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THE NORTH AMERICAN SPECIES OF DROSOPHILA

By A. H. STURTEVANT

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THE NORTH AMERICAN SPECIES OF DROSOPHILA.

I. INTRODUCTION.

Drosophila melanogaster Meigen (*ampelophila* Loew) has in recent years come to be widely used as a laboratory animal, especially in the study of heredity. Its short life-cycle, great productivity, and the ease with which it may be bred have been chiefly responsible for making it so popular for this purpose. These small flies have been used not only in the study of genetics, but also in investigations dealing with cytology, behavior, and various phases of physiology. It has also been found that several other members of the same group are amenable to laboratory life, and these species offer numerous additional possibilities for interesting experimental work, which are now beginning to be exploited.

In view of these facts, it has seemed to the writer that a systematic review of the group would be desirable. No comprehensive study of the American forms has hitherto been made, so that our knowledge of the number of species and of their distribution and habits is very fragmentary. Furthermore, much of the published data on these points is unreliable, for the reason that different names have sometimes been applied to the same form, or different forms have been given the same name. Even when material has been identified by the same entomologist, there is a large possibility of inconsistency—and this applies to the writer's own determinations, for it is very easy to go astray when identifying pinned material. It is hoped, however, that a beginning has been made in the undertaking of bringing order out of something very like chaos.

There was another, somewhat different, reason for making a systematic study of the group. There has been a very large number of mutations discovered in the laboratory races of *Drosophila melanogaster* Meigen, and also of other species, particularly of *D. virilis* Sturtevant. It seemed to the writer that it would be of considerable interest to get an idea of how these mutations compare with the differences between wild species of *Drosophila*. The comparison is difficult to make without crossing species and comparing the inheritance of mutations with that of specific differences. But fertile species hybrids have so far not been obtained in the Drosophilinæ, though many attempts to get them have been made. It nevertheless seemed desirable to discover whether the kind of differences that distinguish wild species are also the kind that are appearing in the laboratory as mutations. This question will be discussed in detail later in this paper.

An attempt has been made to bring together here the more important available information concerning the North American members of the tribe Drosophilinæ, and more especially the genus *Drosophila*. Exotic forms are discussed occasionally, but no extensive treatment of them has been possible. The data concerning the taxonomy, anatomy, development, distribution, and habits of the group are presented as fully as available material will permit. Only a brief survey of the experimental work on the group has been attempted, but a bibliography of the experimental literature (with the more important papers on other lines) is presented.

ACKNOWLEDGMENTS.

This study has been made possible only by the favors and encouragement received from many different sources. It would not be possible to mention here all those who have helped in one way or another toward the completion of the undertaking. There are, however, several to whom my thanks are especially due.

I have made extensive use of the collections and library of the American Museum of Natural History, and am under great obligations to Dr. F. E. Lutz and Mr. A. J. Mutchler for the pains they have taken to facilitate this use. Professor J. M. Aldrich and the late Mr. Frederick Knab, at the United States National Museum, and Mr. C. W. Johnson, at the Museum of the Boston Natural History Society, have given me every facility for studying the material under their care. Extensive loans of material from these three museums have been of very great help. Through the kindness of Mr. Samuel Henshaw and of Mr. Nathan Banks I have been enabled to examine the Loew collection in the Museum of Comparative Zoology at Harvard.

Loans of valuable material have been received from Mr. C. W. Johnson, Professor J. M. Aldrich, Professor A. L. Melander, and Mr. S. W. Frost. Dr. J. C. H. de Meijere has sent me several European species, properly named, and these have been very valuable for comparison with American forms. Mr. C. G. Lamb has supplied valuable information concerning several exotic forms about which I was in doubt.

Local collections of considerable interest have been sent to me by several people. The most significant of these are the following: Dr. O. L. Mohr, from Norway; Professor J. Arias, from Spain; Mr. W. S. Adkins, from Tennessee and elsewhere; Dr. R. R. Hyde, from Indiana and Maryland; Dr. F. Payne, from Indiana; Mr. D. E. Lancefield, from Oregon; Mr. C. T. Ramsden, from Cuba; Mr. L. L.

Gardner, from California; Dr. F. N. Duncan, from Illinois; Dr. C. W. Metz, from Cuba, Isle of Pines, Jamaica, Louisiana, Florida, California, and Long Island.

Dr. C. W. Metz has not only furnished many specimens from interesting localities, but he has furnished a large amount of very valuable data concerning the habits of many rare species. He and the writer collected together in Cuba, and the material recorded here from Havana, Santiago de las Vegas, Guareiras, and Aguada Pasajeros, unless credited to some other collector, is the result of our joint efforts. Dr. Metz and I have worked together for several years in attempts to breed various species in the laboratory, and a very large part of the success that we have had is due to his interest, energy, and ingenuity. From no one else have I received so much help in the collection of the material for this paper, either in the matter of actual data or in that of interest in and encouragement of the work.

During the early part of 1915 I collected in the American tropics, and the success of that trip was in large part due to the facilities given me by Professor Carlos de la Torre at Havana, by Dr. S. T. Darling at Ancon, Canal Zone, and by Dr. A. Alfaro and Professor J. F. Tristan at San Jose, Costa Rica. This trip was made possible by an appointment to a Cutting Fellowship by Columbia University.

II. BEHAVIOR.

REACTIONS TO LIGHT.

The adults of *Drosophila* react positively to light, *i. e.*, they go toward a source of light. This reaction has been studied by Carpenter (1905, 1908), Payne (1911), Lutz (1914), and McEwen (1918). Under conditions of ordinary illumination the movement toward a source of light is noticeable only when the flies are disturbed. It occurs, however, whether the animals walk or fly.

McEwen, whose work is the most extensive and the most recent, concludes that, in *D. melanogaster*, the young females react more strongly than do the males. This sexual difference decreases as the flies grow older, and eventually almost disappears. Both sexes react most vigorously when about 4 days old. Removal of the wings causes the flies to become less responsive to light, and the degree to which the responsiveness is lost is roughly proportional to the amount of the wing that is cut off. As was to be expected from this fact, the mutant races with parts of the wings gone or deformed show the same relations—the smaller the amount of normal wing present, the less marked is the reaction to light.

McEwen has also studied the reactions of several mutant eye-colors to lights of different colors. His general conclusion is that for flies with eye-colors lighter than that of the wild type, the order of decreasing effectiveness for colored lights is violet, green, red. For the wild type and for sepia, a darker eye-color, the order of effectiveness is violet, red, green.

REACTIONS TO GRAVITY.

Adults of *Drosophila* react negatively to gravity, *i. e.*, they usually crawl up rather than down, especially when disturbed. This reaction has been studied in *D. melanogaster* by Carpenter (1905), Cole (1917), and McEwen (1918). Cole found that the negative reaction was shown by the animals when they were crawling, but not noticeably when they were flying. He also found that they reacted negatively to a centrifugal force equal to or greater than gravity. When crawling they reacted negatively to air-currents also; but when flying they usually reacted positively to the same currents, even though they were able to fly against them.

OLFACTORY REACTIONS.

Barrows (1907) has studied the reactions of *Drosophila melanogaster* to odorous substances. He finds that they react positively (are attracted) to various organic compounds found in fermenting fruits—amyl alcohol, ethyl alcohol, acetic acid, lactic acid, and acetic ether.

Mixtures of some of these substances in certain proportions are more effective in producing the reaction than are the pure substances. The reaction consists in a definite orientation toward the source of the odor, followed by movement toward it in a fairly direct path. Removal of the third antennal joints causes the disappearance of this reaction, so that flies so operated on find their food only by accident, if at all.

COURTSHIP AND MATING.

I have described elsewhere (Sturtevant, 1915) the courtship and mating of *Drosophila melanogaster* and certain experiments on sex recognition and sexual selection. It is my purpose here to compare the mating habits of the different species and then to present an abstract of the experimental evidence. The process occurring in *D. melanogaster* may be outlined first, in order to describe certain terms to be used in discussing other species.

Drosophila melanogaster: The first sign of sexual excitement in the male is given when he extends one wing at a right angle to his body and vibrates it very rapidly for a few seconds. This "*vibration*" is repeated at intervals until copulation occurs, and is done now with one wing, now with the other. Between vibrations there is a partial spreading and closing of the wings, done slowly, which I have called "*scissors movement.*" During both these movements the male faces the female, but he may face any part of her body. He usually swings around her in a semicircle several times, facing her as he moves. This I have called "*circling.*" He now *licks* the ovipositor of the female. He bends his abdomen in such a way as to bring his genitalia underneath his thorax, and jerks them toward the female genital organs. If he is successful in copulating he then mounts on the back of the female, between her wings, and holds on to her thorax, wings, or abdomen with his legs. The pair remains in copula for about 21 minutes. The following times have been observed: 1, 5, 16, 17, 17, 18, 18, 19, 20, 20, 21, 21, 21, 21, 22, 22, 23, 24, 24, 25, 26, 27, 29, 33, 35 minutes.

Drosophila affinis: Vibration (both wings at once), scissors movement, circling, male genitalia brought up underneath, as in *D. melanogaster*. As a rule, however, there is not much preliminary to copulation. The same pair was observed to mate twice in 10 minutes. In copula 2, 3 minutes.

Drosophila busckii: Vibration, scissors movement, circling, licking, male genitalia go up underneath. The male has difficulty in getting his head between the wings of the female, and sometimes fails to do so. His front legs rest on her abdomen. His position is always farther back than that of *D. melanogaster*. In copula 2, 2, 2, 3, 3 minutes.

Drosophila cardini: Scissors movement, circling, licking; no vibration seen. In copula 11 minutes. Two pairs seen mated for 23 and

26 minutes, respectively, but the beginning of these cases was not observed; 11 minutes is, however, probably unusually short for this species.

Drosophila caribbea: Scissors movement, circling, licking, abdomen bent up underneath; no vibration seen. In copula about 10 minutes.

Drosophila funebris: Scissors movement, licking, abdomen bent up underneath; no circling or vibration. One wing is sometimes slowly spread to a right angle with the body and then relaxed, without vibration. This motion, which occurs in some other species, I have called "*waving.*" In this species, unlike any of the preceding, the female spreads her wings apart before mating, and the male normally does not attempt to mate until she does spread them. After she spreads them he may mount, and copulate as he does so; he may continue licking, or he may partially mount and not copulate. Even if mating does not occur, the female holds her wings spread apart for about a minute. I removed the wings from two females and placed males with them. In this case the males seemed not to wait for the females to spread the stumps of wings that remained, but attempted to mate before that happened. In copula 13, 14, 16, 18, 18, 19, 20 minutes.

Drosophila hydei: As in *D. funebris.* Copulation may be repeated within 30 minutes. In copula 1, 1, 1, 1, 2, 2, 2 minutes.

Drosophila immigrans: Scissors movement, waving with both wings at once, licking, male genitalia go up underneath; no circling or vibration; female does not spread her wings. The position of the legs of copulating males of this species has been observed in several cases, and has been found to be quite variable, as it probably is in all species. In copula 15, 53, 54, 55 minutes. The female is very restless for about the first 10 minutes.

Drosophila lutzii: No scissors movement, vibration, or circling seen. The male stands behind the female, with his head under her wings, and often stays thus quietly for some time. Then he pushes up against her wings jerkily with his head, at the same time bending his abdomen around to one side. During this act his long axis is not quite parallel to that of the female, and the abdomen comes around the shortest way. The female spreads her wings, and the genitalia come together at almost the same time. The male then mounts, his final position being that which is usual for the genus. Two copulations timed, each lasting about 1 minute.

Drosophila melanica: Not observed in detail, but scissors movement and licking seen.

Drosophila nebulosa: Vibration, scissors movement, licking, but not much of any of them. The male stands facing the female, in front of her and a little to one side. He waves the wing on the side toward the female several times rapidly, at the same time bending his abdomen around toward her. He sometimes goes to the other side, but usually circles rapidly to the rear. No wing-motion by the male has been seen when he was in any position but the above. When he circles to the rear, the female may spread her wings as in *D. funebris*. The male then rushes in and copulates. One pair in copula 2 minutes.

Drosophila obscura: Vibration (both wings at once), scissors movement, circling, male genitalia go up underneath. The female does not spread her wings. In copula 4, 5, 5, 6, 6, 6, 6, 7, 7, 8, 8, 11 minutes.

Drosophila repleta: Scissors movement, licking; no vibration or circling. The female spreads her wings as in *D. funebris*, but not so widely. After the genitalia become separated the male remains in position for about 30 seconds. One pair copulated twice within 10 minutes. In copula 2, 3 minutes.

Drosophila robusta: Scissors movement, waving, licking; no vibration or circling. The female does not spread her wings before the male mounts. In copula 2 minutes.

Drosophila simulans: Vibration, scissors movement, circling, licking, male genitalia go up underneath, female does not spread her wings—all as in *D. melanogaster*. In copula 19, 20, 23, 25, 25, 32, 32, 36, 48 minutes.

Drosophila transversa: Scissors movement, rapid waving, circling, licking. No vibration seen. Copulation itself not observed. (These notes possibly refer to *D. putrida*.)

Drosophila virilis: Scissors movement, waving, licking; no vibration or circling. The female spreads her wings before the male mounts. If he fails to mount she keeps them apart a few seconds. The male genitalia go up underneath. Mounting is done slowly. In copula 2, 3, 4, 4, 4, 5 minutes.

Drosophila willistoni: Scissors movement, licking; no circling or vibration seen. In copula 27 minutes.

Drosophila hypocausta Osten Sacken: De Meijere (1914. Tijds. v. Entom., 54) has given notes from Jacobson showing that courtship in this oriental species is accompanied by circling and licking.

Scaptomyza adusta: Very little courtship, all done from behind the female. Occasional scissors movement, slight vibration, not much licking, no circling. Male rushes at female and doubles his abdomen up underneath; usually fails to mate. The female does not spread her wings. Mounting does not occur until the genitalia are connected. The final position is the same as in most species of *Drosophila*. In copula 8 minutes.

Scaptomyza graminum: Same as *S. adusta*. In copula 3 minutes.

Chymomyza amœna: None of the characteristic acts of courtship in *Drosophila* seem to occur in this genus, except that a modified waving is constantly being done by both sexes even when not sexually excited.

The male rushes at the female, with his abdomen bent up underneath, and grasps her wings with his front legs, holding them between his femora and tibiæ. The comb of bristles on the front femora, a secondary sexual character occurring in all the species of the genus known to me, seems to be connected with this holding of the wings. The female struggles when caught, and usually escapes. If she does not escape immediately she soon becomes quiet, and the male attempts to mate. No successful copulation has been observed, though in one case a male kept hold of the wings of a female for 15 minutes and repeatedly attempted to mate.

Chymomyza procnemis: The male runs after the female, and when she stops pushes her wings apart with his head, grasps them with his front legs (as in *C. amœna*), mounts, and attempts to mate. He repeatedly grasps the region of her ovipositor with his large genital claspers, the abdomen being bent up underneath. Usually after about a minute copulation occurs. In copula 8, 9, 18, 18 minutes.

The forms described may be roughly classified as follows:

1. Mounting before copulation; male holds wings of female: *Chymomyza amœna, C. procnemis.*
2. No wing courtship; abdomen goes up at side: *Drosophila lutzii.*
3. All wing movement in front of female; abdomen bent around at side; female spreads her wings: *Drosophila nebulosa.*
4. Little wing-movement; female spreads her wings: *Drosophila funebris, D. hydei, D. repleta, D. virilis.*
5. No vibration; female does not spread her wings: *Scaptomyza adusta, S. graminum, Drosophila caribbea, D. cardini, D. immigrans, D. robusta, D. willistoni.*
6. Vibration, circling; female does not spread her wings: *Drosophila affinis, D. busckii, D. melanogaster, D. obscura, D. simulans.*

Insufficient data: *D. hypocausta, D. melanica, D. transversa.*

The members of the genus *Chymomyza* mount before copulation; in *Drosophila* and *Scaptomyza* copulation precedes mounting. The former relation is the one that appears to be usual among other Muscidæ. It occurs in the Calypteræ in general, and in all the Acalypteræ that I have observed, belonging to the subfamilies Sepsinæ, Piophilinæ, Trypetinæ, Borborinæ, and Ephydrinæ.

The final position of mated pairs is in general the same throughout the group of Drosophilinæ, so far as observed. The same position is the rule in the rest of the Muscidæ. I have observed it in many Calypteræ and in the acalyptrate subfamilies mentioned in the preceding paragraph, as well as in the Cordylurinæ. It occurs in some, but not in all, Syrphidæ. The only exception known to me among the Muscidæ is in the case of the genus *Lonchæa*, one mated pair of which I have observed. This pair was in the end-to-end position; but that may not be the normal process for the species (apparently *L. polita* Say).

CROSS-COPULATION.

Males of *Drosophila melanogaster* will copulate with females of *D. affinis*, *D. obscura*, or *D. simulans*. Only the combination with *D. obscura* has been studied in any detail. As we have seen, the two species differ in the length of time they remain in copula, the average time for *D. obscura* being about 6 minutes, that for *D. melanogaster* about 21 minutes. In the case of the cross-mating the time is much more variable than in any intraspecific mating yet studied. The following times have been observed: 1/2, 1, 1, 1, 1, 1, 1, 1, 1, 3, 3, 4, 6, 6, 7, 8, 10, 10, 11, 12, 13, 14, 15, 16, 16, 18, 18, 23, 24, 25 minutes. This combination has been tried in many ways, but always without the production of offspring. Each sex has been allowed to mate with its own species before cross-copulating, and such preliminary matings have sometimes been interrupted before finished, sometimes allowed to stop normally. Cross-mated females have been mated later to *D. obscura* males. Numerous different races have been tried, and females of many different ages have been used. Nevertheless, no hybrids have ever been obtained. The combination of *D. melanogaster* male and *D. affinis* female has not been tried so extensively, but it has so far failed to give any hybrid offspring.

The crosses between *D. melanogaster* and *D. simulans* are occasionally fertile in both directions. The hybrids are discussed elsewhere in this paper (p. 117). The cross-mating has not been studied in detail, but a small series of experiments makes it highly probable that each species is more apt to mate with individuals of its own species than with those of the other form. This selective relation is apparently due chiefly to the females, since males of each species seem to court, but not to mate with, females of either species indiscriminately.

The hybrid females are mated with by males of both species. In the only case in which the whole process was watched, a male of *D. simulans* was placed with a female *D. melanogaster* and a hybrid female, both females being of the same age and size. He mated with the hybrid female, the pair remaining in copula 28 minutes.

EXPERIMENTS CONCERNING SEXUAL SELECTION.

Lutz (1911) removed the "sex-combs" on the front tarsi of males of *D. melanogaster*, and found that such males were as apt to mate as were normal males. The significance of this secondary sexual character—if it has any significance—has not been determined.

As appears from the description above, the wings of the male play a conspicuous part in the courtship of *D. melanogaster*. I have performed some experiments in an attempt to discover the function of these wing movements (Sturtevant, 1915). These experiments showed that a male with wings excites a female sexually, so that she is ready to mate, more quickly than does a male from which the wings have been removed. But when the female is ready to mate, she will mate with a wingless male almost, if not quite, as readily as with a normal winged one.

An extensive series of experiments with various mutant types (Sturtevant, 1915) indicated that neither males nor females exercised any "choice" of mates with respect to the characters studied. Usually the mutant-type is less active than the wild-type. In such a case, the mutant male mates less often than does the wild-type male, since he courts less vigorously and persistently. But the mutant female is mated with more often than is the wild-type female, since she is less active in running away from the male.

SEX RECOGNITION BY THE MALE.

All attempts to induce courtship by means of visual or of olfactory stimuli alone have failed in *Drosophila.* Mating occurs in the dark, indicating that sight is not necessary. Males without antennæ will mate, and Barrows's experiments (see above) indicate that the organs of smell are located in the third antennal joint. Yet there is evidence that both sight and smell may play a part in the process.

I compared the time before copulation occurred in two parallel series of pairs of *D. melanogaster.* One series was placed in clean vials; the other in vials in which another pair had just copulated. The second series mated significantly sooner, on the average. This can only mean that olfactory stimuli had hastened sexual excitement.

When a male of *D. melanogaster* is courting a female she frequently walks or flies away. He orients toward her and follows her accurately if she is only a few millimeters away, but never orients accurately if she is as much as a few centimeters away. In the latter case he often becomes excited, and shows movements characteristic of courtship; but he finds the female again only by accident. This behavior is not changed if one antenna is removed. Circus movements do not then occur when the male becomes sexually excited, and the female, if she is close enough, is followed as accurately as before. This seems to me to indicate that orientation toward the female is by means of visual stimuli. This view is borne out by the fact that sexually excited males will sometimes orient toward and follow other males, though only rarely does one male cause sexual excitement in another one. The hypothesis is also in agreement with Barrows's observation that orientation toward olfactory stimuli (food) occurs at distances much greater than those at which a sexually excited male can orient toward a female.

The failure of olfactory stimuli alone to produce courtship, the fact that males without antennæ will mate, and some observations of normal courtship, all suggest that tactile stimuli may be involved; but no direct evidence for this conclusion is at hand.

DURATION OF COPULATION NECESSARY.

As shown above, the length of time pairs remain mated is characteristic for each species, ranging from about a minute in *Drosophila lutzii* to about an hour in *D. immigrans*. The usual time for *D. melanogaster* is about 21 minutes. I have conducted a few experiments with this species, to see how long a time is necessary. Nine pairs were mated, in each case using a male with a dominant mutant character, so that any offspring produced could be identified as his and not due to a previous mating. These pairs were allowed to mate, and were then shaken apart after a few minutes. The females were then isolated to see if they would produce offspring. In no case was a complete count of the offspring made, so that the figures given in table 1 represent only minimum numbers. Evidently 8 minutes is about the time required.

TABLE 1.

Time, in minutes, pair was mated	3	4	6	6	6	8	8	10	16
Number offspring produced	0	0	0	0	0	0	67	35	88

III. GENETICS.

Drosophila melanogaster has been more extensively used in the study of genetics than any other organism, and the theory of heredity that is now generally accepted is based chiefly on the results obtained with this fly.

The first paper on the genetics of *Drosophila* was published in 1906 (Castle *et al.*); the first mutation in *D. melanogaster* was reported in 1910 (Morgan). Since that time about 150 books and papers dealing with heredity in the genus have been published. About 250 different mutant types have been discovered and studied, and at least 10,000,000 living individuals have been etherized and examined by more than a score of investigators. The problems studied include practically every branch of the subject of genetics. Not only has *Drosophila* been the most productive material for research in the subject, but it is now the standard object for laboratory instruction, and is used as such in many colleges and universities.

The mutant-types produced by *D. melanogaster* are of very many kinds. Eye-colors ranging from pure white to deep sepia are known, and general body-colors from pale yellow to dark black-and-brown. The shape of the eye and the character of its surface are both affected by mutation. The wings are shortened, changed in shape, have parts lost, or are entirely wanting. The bristles may be deformed, increased or decreased in number, or made small. The microchætæ may be disarranged, reduced in number, or may occur in areas normally bare. Extra veins may occur, or veins normally present may be thickened, weakened, displaced, reduced, or lost. The legs may be misshapen, have missing parts, or be increased in number. Giants and dwarfs are both known. There are types that always die before metamorphosis, and there are types in which the females are always sterile; others in which the males are always sterile. All these and many others have been shown to differ from the usual or "wild-type" form by definite, heritable, and relatively stable units known as genes.

New or "mutant" genes arise only rarely, and their appearance is not under control. Once arisen, they are perpetuated simply by breeding from individuals that bear them. It has been found that the 250 or more genes known in *D. melanogaster* are not inherited entirely independently, but fall into four groups. The members of any one group are entirely independent of all members of any other group, but are more or less closely associated in inheritance with the members of their own group. These four groups correspond in size and in many other ways with the four chromosome pairs of this species; and it seems certain that the genes in any one group are associated because they lie in the same chromosome pair, and for no other reason.

It has been found possible to determine the linear order of the genes within any one chromosome pair and to obtain a measure of their distance apart. On the basis of this information, when the position of a new gene has been determined with respect to any two others in its group, it is possible to predict accurately the relations that it will show to any other genes. For the methods used in these analyses, and for numerous other special developments of the subject, the reader is referred to the following publications:

Brief accounts:

Wilson, E. B. 1913. Heredity and microscopical research. (Leidy lecture.) Science, n. s., 37: 814–826.

———. 1914. The bearing of cytological research on heredity. (Croonian lecture.) Proc. Roy. Soc. B, 88: 333–352.

Morgan, T. H. 1915. The constitution of the hereditary material. Proc. Amer. Phil. Soc., 54: 143–153.

———. 1915. Localization of the hereditary material in the germ cells. Proc. Nat. Acad. Sci., 1: 420–429.

——— and C. B. Bridges. 1916. (Introductory portion of) Sex-linked inheritance in Drosophila. Carnegie Inst. Wash. Pub. No. 237, 87 pp., 2 plates.

Nachtsheim, H. 1919. Die Analyse der Erbfaktoren bei Drosophila und deren zytologische Grundlage. Zeits. ind. Abst. Vererb., 20: 118–156.

Full treatments:

Morgan, T. H. 1916. A critique of the theory of evolution. Princeton. 197 + x pp.

———. 1919. The physical basis of heredity. 305 pp. Philadelphia.

———, A. H. Sturtevant, H. J. Muller, and C. B. Bridges. 1915. The mechanism of Mendelian heredity. 262 + xiii pp. New York.

Babcock, E. B., and R. E. Clausen. 1918. Genetics in relation to agriculture. 675 + xx pp. New York.

Descriptions of mutants:

Morgan and Bridges. 1916. (See above.)

Bridges, C. B., and T. H. Morgan. 1919. The second chromosome group of mutant characters. Carnegie Inst. Wash. Pub. No. 278, pp. 123–304, 7 plates.

MUTATIONS IN SPECIES OTHER THAN D. MELANOGASTER.

Several other species of *Drosophila* have been examined for mutations, though none so extensively as *D. melanogaster*. There is now convincing evidence that mutations occur with something like the same frequency in these species; that the mutants are of the same general nature; that in some cases the same identical mutation has occurred in different species; and that the genetic behavior of these other species is in general very similar to that of *D. melanogaster*. There follows an abstract of the available data on these species, arranged alphabetically:

D. affinis: Hyde (1915) has reported a "jaunty" wing, inherited as a non-sex-linked recessive. He used the name "confusa" for this species, which was at that time undescribed.

D. busckii: Warren (1917) found two eye-colors, both recessive and not sex-linked, but apparently lying in the same chromosome.

D. caribbea: I found a curved wing that was a non-sex-linked recessive (unpublished data).

D. funebris: Two papers: Sturtevant (1918), Mohr and Sturtevant (1919). These papers, and certain unpublished data of my own, indicate the existence of at least 5 mutations, in at least three different chromosome pairs. Three of these are probably identical with mutations previously discovered in *D. melanogaster;* two of the latter are in the same (the X) chromosome pair, and show a linkage relation similar to but not identical with that shown by the same two genes in *D. melanogaster*.

D. hydei: Hyde (1915) recorded a non-sex-linked recessive eye-color in this species. The form had not then been distinguished from *D. repleta*, and Hyde used that name for it.

D. immigrans: Metz and Metz (1915), using the name *D. tripunctata*, recorded a non-sex-linked recessive venation character. I have found about five mutations in this species, lying in at least three different chromosome pairs. One of them has appeared in two entirely different stocks, caught wild in widely separated localities. (Unpublished data.)

D. obscura: I have found a non-sex-linked recessive, "spread" wing (unpublished data). Metz (1916) has recorded three mutations in this species—one sex-linked and two not. Mr. D. E. Lancefield has unpublished data on numerous mutations in this species.

D. repleta: A sex-linked body-color occurs in nature (Sturtevant, 1915). The data published concerning the distribution of this form need revision, as they were based on classifications of material that included *D. hydei* and *D. mulleri*, as well as *D. repleta*. It is certain that the rarer type occurred in New York and in Arkansas; but all the other records are doubtful. I have more recently obtained two other mutations in this species, but neither of them was favorable for extensive study (unpublished data).

D. similis: Metz (1916) has studied a non-sex-linked recessive eye-color called "chocolate."

D. simulans: The first mutant in this species was found in the wild state by Dr. C. W. Metz. I have found about ten others since then; five of these mutants have been crossed with similar mutant races of *D. melanogaster*, and have thereby been shown to be due to changes in the same genes as in that species. Four of these are in the X chromosomes, and have the same sequence in the two species. Linkage between sex-linked genes, non-disjunction of the sex chromosomes, and gynandromorphism have all been shown to occur here and to be closely similar to the same phenomena in *D. melanogaster*. All the data on this species are still unpublished.

D. virilis: Metz (1916, 1917, 1918) has studied this species in some detail. He has reported 16 mutations, 8 of which are sex-linked, and has determined the positions of the latter on the X chromosome. At least three groups of genes are represented. Three of the mutations appear to be the same as previously known ones in *D. melanogaster*.

D. willistoni: Dr. Metz has unpublished data on a number of mutations in this species, and on their interrelations.

IV. PHYSIOLOGICAL STUDIES.

EFFECT OF HUMIDITY ON PUPÆ.

Elwyn (1917) has studied the effects of differences in humidity on pupal mortality and on the duration of the pupal stage in *Drosophila melanogaster*. He found that the duration of this stage was the same at humidities of 100 per cent, 64 per cent, and 0 per cent; but the mortality was greater at lower humidities: 2.5 per cent at 100 per cent humidity, 12.3 per cent at 64 per cent humidity, 52.9 per cent at 0 per cent humidity. The mortality was also greater, at the lower humidities, among pupæ isolated very soon after pupation than among those a few hours older. This was presumably because the pupa-case did not harden enough to interfere seriously with evaporation until a few hours after pupation.

EFFECT OF TEMPERATURE ON LENGTH OF LIFE.

Loeb and Northrop (1917) found that temperature affects the duration of the larval and pupal stages and the length of life of the adult. Their later experiments were carried out in bacteriologically sterile cultures (see below). They concluded that the duration of each of these stages was halved (or decreased even more than that amount) by each rise of 10° C. in temperature. This temperature coefficient is stated to be similar to that observed for many life processes and for chemical reactions. Loeb and Northrop also found that, at each temperature studied, the duration of the larval period is about 1.4 times as long as that of the pupal stage, and about 0.2 as long as the life of the imago. That is to say, different temperatures affect the different stages proportionately.

NUTRITION.

Henneberg (1902) first pointed out that *Drosophila* larvæ probably live chiefly on yeast cells. This has been confirmed by Delcourt and Guyénot (1910, 1911), Guyénot (1917), Loeb and Northrop (1916), and Baumberger (1917, 1919). The recent workers have all used bacteriologically sterile cultures. Delcourt and Guyénot obtained such cultures by the "dilution method" of repeatedly placing females on fresh sterile media for short periods. They ultimately obtained cultures in this manner that were sterile by bacteriological tests. Loeb and Northrop sterilized eggs by washing them with a solution of corrosive sublimate. Baumberger sterilized puparia by washing them with 85 per cent alcohol. The investigations of these workers show that the larvæ of *D. melanogaster* feed principally on yeast, but can utilize dead yeast as effectively as live yeast. Certain kinds of bacteria may be substituted for yeast, and a few larvæ can be brought to pupation on sterile banana without either yeast or bacteria. Powdered mushroom and concentrated banana were more efficient as food than was unconcentrated banana, but much inferior to yeast (Baumberger). Some yeast cells pass undigested through the body of the larva. These, and others adhering to the surface of the larva, are scattered through the fruit in which the larva burrows, and reproduce there. Thus a loose symbiosis exists between *Drosophila* and yeasts (Baumberger).

NATURAL FOOD OF DROSOPHILA LARVÆ.

The larvæ of Drosophilinæ may, in general, be termed scavengers. As we have seen, they are probably primarily yeast-eaters, and the material in which they occur is favorable for their development only in so far as it forms a good culture-medium for yeasts. On this view the marked specific differences in food-habits might be due to differences in the olfactory reactions of the adults, causing them to be attracted to or to oviposit on different substances, or to a difference in the kind of yeast (or bacteria) favored as food. Only a careful study of some of the different species can show what is the correct interpretation of these food habits.

The genera *Titanochæta*, *Acletoxenus*, and *Gitona*, and the "inversa group" of *Drosophila*, are apparently true parasites. The members of the genus *Scaptomyza* are, primarily but not invariably, leaf-miners. *Leucophenga* larvæ are most often to be found in fleshy fungi, and *Zygothrica* and *Mycodrosophila* are, so far as known, limited to that food. *Chymomyza* species usually breed in fruit or in the sap of bleeding trees. Within the large and varied genus *Drosophila* occur many and diverse food-habits. Each species has a characteristic type of food, not always adhered to, but nevertheless usual. These may be roughly classified as follows:

1. Parasitic on cercopids: *D. inversa*, *D. paradoxa*.
2. Corollæ of large flowers: *D. floræ*, *D. lutzii*.
3. Fungi: *D. guttifera*, *D. putrida*, *D. transversa*.
4. Decaying fruit: Most of the common species.
5. General scavengers, *i. e.*, rotten potatoes, excrement, stale formalinized meat, etc.: *D. busckii*, *D. funebris*.

The last two types are not as distinct as the others. Such forms as *D. caribbea*, *D. hydei*, and *D. repleta* are intermediate between these two types. They are commoner about fruit than the members of type 5, but are attracted to excrement and other substances of the kind about which type 5 species occur. All three of these have been bred from fruit.

BANANA AGAR.

Laboratory cultures of *Drosophila* are usually reared on banana agar. This is made up by taking equal amounts (by weight) of water and banana, with enough agar to make 1 per cent of the total. The water is boiled and the agar dissolved in it. The banana is usually run through a "potato ricer," and then added to the agar solution. Some workers add sodium hydroxide or carbonate to the mixture, but it is best not to add enough to cause an alkaline reaction to litmus. While still hot the solution is poured into the culture bottles and allowed to harden. Half-pint milk-bottles are very convenient for this purpose. About 50 c. c. of banana agar to a bottle will give good results. A very little powdered yeast is sprinkled over the surface of the agar in each bottle. A piece of absorbent paper (paper toweling is usually used) a few inches square is added, and the bottle is stoppered with cotton. The flies may be introduced as soon as the bottle cools; the bottle should not be kept longer than 48 hours before using.

This culture medium has been found very favorable for many species. *Drosophila melanogaster*, *D. simulans*, *D. obscura*, *D. funebris*, *D. immigrans*, *D. virilis*, and *D. willistoni* have all been bred on it very extensively in pairs. Mass-cultures of numerous other species, including members of the genera *Scaptomyza* and *Chymomyza*, have been found to thrive on it.

V. PARASITES AND ENEMIES OF DROSOPHILA.

Protozoan parasites: Chatton and his coworkers (1908, 1911, 1912) have described flagellate parasites from the digestive tract and Malpighian tubules of the European *Drosophila confusa* Staeger. These are described as probably belonging to four distinct genera; but Minchin (1912, Introduction to the Study of the Protozoa) interprets them as different stages of the same parasite, which he places in the genus *Leptomonas*. The effects produced on the hosts, and whether or not other species of *Drosophila* have the same or similar parasites are points not yet known.

Fungus parasites: Thaxter (1895, Mem. Amer. Acad. Arts and Sci., 12, 300; 1914, Botan. Gaz., 58, 235; 1917, Proc. Amer. Acad. Arts and Sci., 52, 699) has described several fungi that are external parasites on species of Drosophilinæ. These fungi belong to the genera *Muiaria* (Hyphomycetes) and *Stigmatomyces* (Laboulbeniales). Each of these genera is recorded both from *Drosophila* and from *Leucophenga*. The effects on the hosts are apparently unknown.

Nematodes and mites: Small mites are frequently to be found crawling over living specimens of *Drosophila*. When numerous they are apparently harmful, but I have not determined the manner in which they affect the host.

Soil-living nematodes often occur in enormous numbers in fruit exposed on the ground, and *Drosophila* fed on such fruit sometimes has tangled masses of worms on its legs, wings, and bristles. These appear as opaque white masses. They are injurious in that they impede the movements of the fly and make it sluggish.

Hymenopterous parasites: The young stages of *Drosophila* are parasitized by various species of Hymenoptera. Ashmead has described a few species, Martelli (1910) has given an account of others, and I have bred a few. Perkins (1913) states that he has bred at least five species of parasitic Hymenoptera (belonging to the proctotrupoid, cynipoid, and chalcidoid groups) from the larvæ of Hawaiian Drosophilinæ. I am inclined to think, however, that these forms are not very serious enemies. They do not often emerge from exposed fruit that contains *Drosophila* larvæ and pupæ.

Predacious enemies: Fermenting fruit frequently contains predacious beetle larvæ (Staphylinidæ and apparently Nitidulidæ), that must destroy many *Drosophila* larvæ. I think these are probably the most serious natural enemies of Drosophilinæ.

I have seen domestic fowls scratching apart fleshy fungi and eating the larvæ contained therein. These larvæ were chiefly Phoridæ, but some of them were Drosophilinæ (*Leucophenga* and *Mycodrosophila*).

Adults are preyed upon by spiders and by flies of the empidid, cordylurine, and anthomyiine groups. I have seen an empidid, *Elaphropeza flavida* Williston, destroy many Drosophilinæ in Cuba, where the species is common.

Perkins (1913) states that, in Hawaii, a crabronid wasp often fills its cells with a species of *Drosophila*.

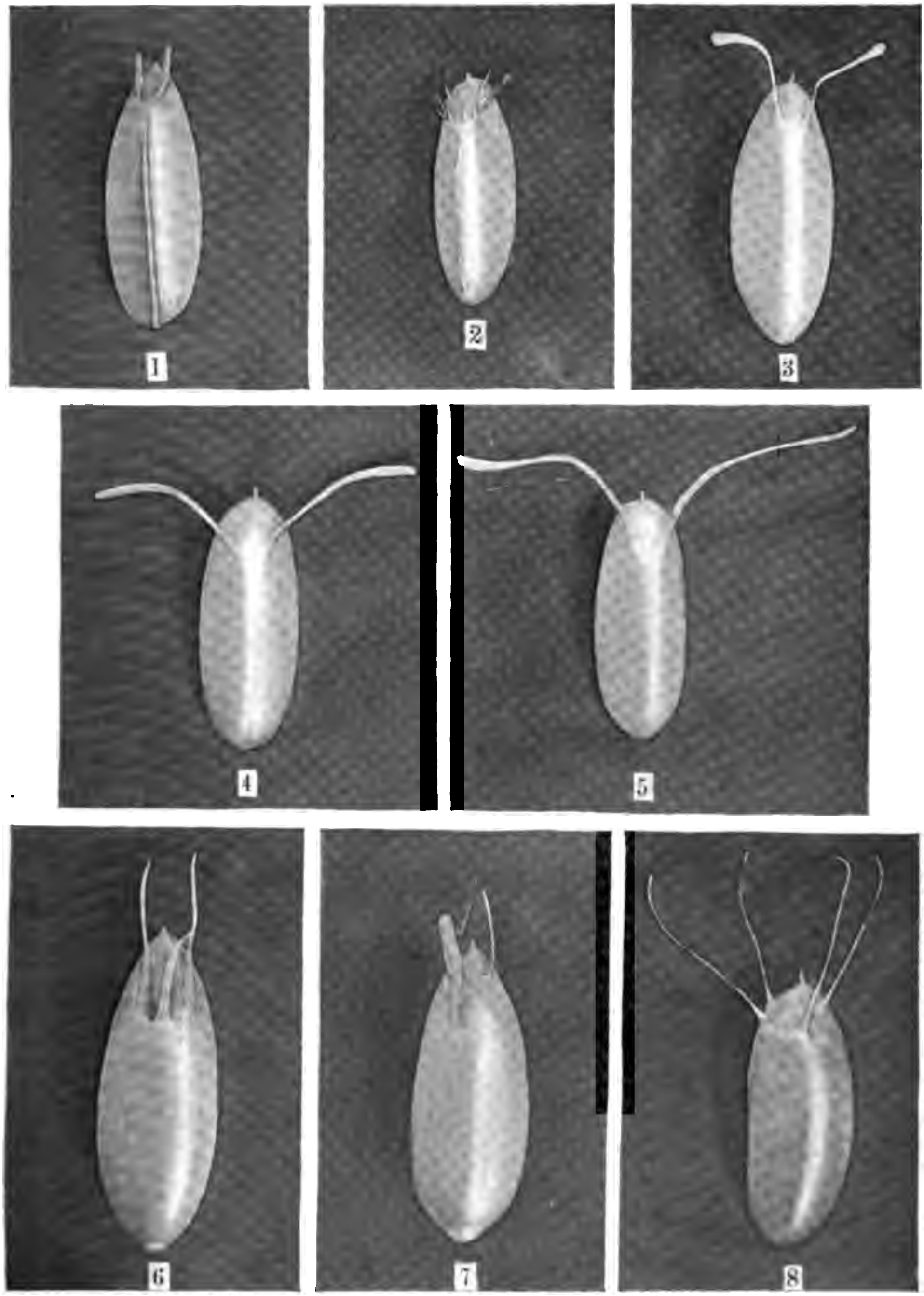
VI. ANATOMY.

The following account of the structure of the various stages has been made sufficiently general to apply to all the members of the genus *Drosophila* known to me, and usually to the other members of the subfamily also, unless otherwise stated. In most cases the points have been worked out first with *D. melanogaster*, *D. funebris*, or *D. immigrans*, and then checked up by an examination of other species. Throughout the preparation of this part of the paper I have had on hand living stocks of about 15 species belonging to the genera *Drosophila*, *Chymomyza*, and *Scaptomyza*, as well as slides of larvæ and cleared specimens of numerous other forms. Many of the points have been checked by examination of pinned material of the rarer species.

EGGS.

The eggs of several species of Drosophilinæ are shown in plate 1. Those of *Drosophila melanogaster* are about 0.6 mm. long, those of *Chymomyza procnemis* about 0.5 mm. All the species in which I have investigated the matter have white eggs, with a fine meshwork of raised lines (not shown in the figures) over their surfaces. These are apparently the remains of the follicle cells that secreted the chitinous egg-shell. The filaments at the anterior end are present in all the

PLATE 1



EGGS OF CERTAIN DROSOPHILINÆ.

1. Scaptomyza graminum.
2. Chymomyza procnemis.
3. Drosophila affinis.
4. Drosophila melanogaster.
5. Drosophila simulans.
6. Drosophila quinaria.
7. Drosophila transversa.
8. Drosophila funebris.

eggs that I have seen, with the possible exception of those of *Leucophenga varia.* These structures are, however, different in number and shape in the different species, and afford excellent specific characters. They lie spread over the surface of the food when the egg is laid normally, and apparently keep the anterior end of the egg from sinking below the surface.

The micropyle is situated in the small papilla that can be seen at the anterior tip of the egg. The sperm probably enters here.

The larva emerges from the anterior end of the egg, squeezing through an irregular opening formed by a split in the chitinous shell of the egg.

The eggs known to me may be classified as follows:

1.	Eight or more filaments	*Chymomyza*	3
	Two, three, or four filaments		2
2.	With a ridge above; filaments short	*Scaptomyza*	4
	No ridge on upper side	*Drosophila*	5
3.	Usually eight filaments	*C. procnemis*	
	Ten filaments	*C. amœna*	
4.	Two filaments	*S. graminum*	
	Four filaments	*S. adusta*	
5.	Three filaments		6
	Two filaments		7
	Four filaments		8
6.	Median filament slightly thicker than either of the two lateral ones	*D. quinaria*	
	Median filament more than twice as thick as either of the two lateral ones	*D. transversa*	
7.	*D. affinis, D. caribbea, D. earlei,*[*] *D. melanica, D. melanogaster, D. nebulosa, D. obscura, D. simulans.*		
8.	*D. busckii, D. cardini, D. funebris, D. hydei, D. immigrans, D. putrida, D. repleta, D. robusta, D. similis,*[*] *D. torrei, D. tripunctata,*[*] *D. virilis.*		

Anterior filaments are described for the eggs of the genus *Scatophaga* (Cordylurinæ), but are absent in the described Calypteræ, Trypetinæ, and Agromyzinæ.

LARVÆ.

Various drosophiline larvæ have been more or less thoroughly described by Heeger (1851), Comstock (1893), Howard (1900), Unwin (1907), Martelli (1910), Johannsen (1910), Banks (1912), Keilin (1915), and de Meijere (1916).

According to Keilin, the larvæ of *D. melanogaster* pass through three stages, separated by two larval molts. As in most other cyclorhaphous Diptera, the anterior spiracles do not appear until after the first molt, and the cephalopharyngeal skeleton becomes larger and stouter at each molt. The first-stage larvæ have a chitinized median plate, dorsal to the pharynx and just behind the mouth-hooks, which is not present in the second or third stage larvæ. Keilin has seen this plate also in first-stage larvæ of Borborinæ and Sepsinæ.

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[*] The eggs of these species I have not seen. The number of filaments is given on the authority of Dr. C. W. Metz.

I have not examined the two younger stages, nor studied the transitions between them, beyond observation that the cephalopharyngeal skeletons are cast off and may be seen in the food. The following notes all apply to third-stage larvæ.

The body is divided into 12 visible segments, though unless the animal is fully extended one of the thoracic segments (numbers II to IV) is apt to be overlooked. The mouth-opening is on the first or head segment. This segment also bears a pair of small papillæ, known as antennæ, and two pairs of small organs apparently sensory in function. The sensory organs and their nervous connections are figured by Keilin. The anus and posterior spiracles are on the twelfth (eighth abdominal) segment.

There are minute hooklets irregularly scattered over the surface of the larva, but these are not easily seen except in eight bands of four rows each that lie on the ventral surface of the larva, at the anterior edge of each abdominal segment. In these bands the hooklets are larger and darker in color than over the rest of the body. There are several processes ("pseudopodia") on the last segment—usually three with one or two papillæ on each. From the upper posterior part of this segment arise the posterior spiracular processes, each of which bears a papilla on its upper surface. Each process ends in a chitinized tube that has at its tip three spiracular openings that are surrounded by very slender outwardly directed chitinous rays. When the larva is feeding it lies buried in the food, with only the tips of these spiracular processes exposed to the air. The rays around the openings evidently serve to prevent the openings themselves from sinking below the surface and thus cutting off the air-supply of the larva. A large trachea runs forward from each posterior spiracle and connects with the anterior spiracle of the same side. Each of these tracheal trunks gives off numerous lateral branches, and not far from the anterior spiracles there is a large cross-connection between the two trunks. There is another cross-connection situated just anterior to the posterior spiracles. The anterior spiracle of *Drosophila funebris* is shown in figure 1. The same type occurs in all drosophiline larvæ that I have seen. It is chitinous, and may be extruded somewhat.

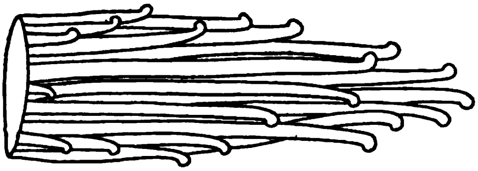


FIG. 1.—Anterior spiracle of third-stage larva of Drosophila funebris.

The cephalopharyngeal skeletons or "jaws" of a few species are shown in figures 2, 3, and 4. These structures are jet black, except for the more posterior processes, which are brownish. The names of the parts that appear in figure 2 are from de Meijere's account of *D. obscura*. All the parts shown in these figures are paired, and the organs of the two sides are connected in two places only. The halves of the mentum have a cross-connection below, near the middle, and both vertical plates are attached to a single "latticed process." There is also an unpaired *prementum*, not shown in these figures, lying between the halves of the mentum and at the level of the apex of the lateral process.

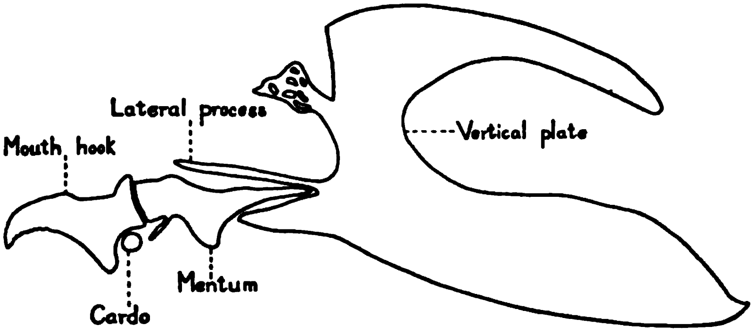


FIG. 2.—Cephalopharyngeal skeleton of third-stage larva of Drosophila melanogaster.

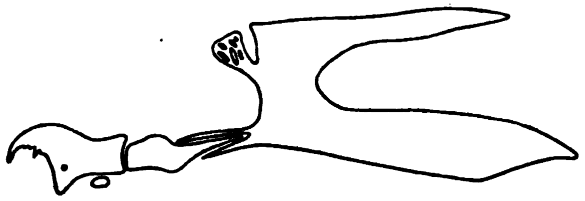


FIG. 3.—Cephalopharyngeal skeleton of third-stage larva of Drosophila funebris.

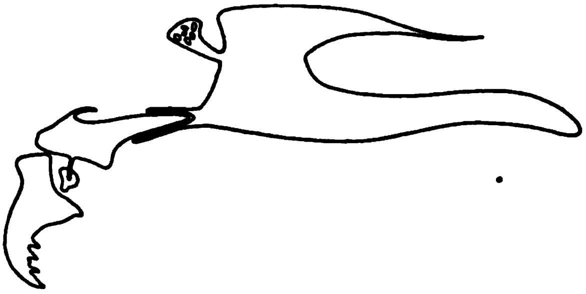


FIG. 4.—Cephalopharyngeal skeleton of third-stage larva of Scaptomyza adusta.

Fabre believed that the corresponding apparatus in the blow-fly served as an organ for locomotion rather than for mastication. Observation of living *Drosophila* larvæ has convinced me that, in this group at least, mastication is its primary function. Locomotion is usually accomplished by the help of the backward-pointing ventral hooklets. The larva stretches its segments apart, and then contracts them, waves of extension and contraction passing anteriorly. The ventral hooklets prevent the segments from slipping backwards, and locomotion results.

Dr. C. B. Bridges has dissected the gonads from numerous fully grown larvæ. He finds that they are situated between the third and fourth main lateral branches of the longitudinal tracheal trunks, counting from the posterior end. Each gonad is embedded in a fat-body, one lying on each side of the body of the larva. The ovary at this stage is a very small spherical body, somewhat more transparent than the surrounding fat-body. The testis is much larger, ovoid, and quite transparent.

The fully grown larvæ of *Drosophila cardini* and of *D. saltans* "skip" in the same way as do those of *Piophila* and a few other Acalypteræ (*e. g., Epochra* among the Trypetinæ). The larva bends around and grasps its posterior end with its mouth-hooks. The body is then straightened and the hooks pull loose suddenly. The body straightens immediately, and is thus caused to spring several inches into the air. I have not observed any morphological structures of the larvæ associated with this curious habit. This habit has been looked for in very many other species, but I have not yet found it, except in the two forms just named. Malloch (1915) has, however, reported it in a species of *Drosophila* bred by him.

The larva of *Drosophila busckii* bears, on the dorsal surface of each segment from the fourth to the twelfth, about eight branched processes similar to those present on certain anthomyiine larvæ. This is evidently the form figured and described by Riley (1918) as found in milk-bottles.

In the genus *Scaptomyza* the bands of ventral hooklets are less distinct than in most species of *Drosophila*. In *Chymomyza* the anterior band is not evident.

Drosophiline larvæ differ from some other described acalypterate larvæ in having the posterior spiracular openings on definite raised processes. This condition is found in *Hydrellia* (Ephydrinæ) and *Leuçopis* (Ochthiphilinæ) by Keilin, and in a species of *Agromyza* by Webster and Parks, but does not occur in the numerous species of Calypteræ, Ortalinæ, Trypetinæ, and Piophilinæ studied by Banks.

PUPÆ.

Drosophila, like other cyclorhaphous Diptera, pupates within the last larval skin. The fully-grown larva crawls out of the food, apparently in nature coming to rest usually in the loose surface soil. The anterior spiracles are extruded to form the "horns" of the *puparium*, as the combined pupa and larval skin is called. The larval skin, at first soft and white, hardens and turns brownish in the course of a few hours. The final color is dark reddish-brown in *Chymomyza procnemis*, *Drosophila funebris*, *D. immigrans*, *D. repleta*, *D. virilis*, and others, paler and not reddish in *D. melanogaster*, *D. obscura*, *D. simulans*, and others. The posterior spiracles and "pseudopodia" and the ventral hooklets (also the dorsal processes of *D. busckii*) of the larva are retained in the puparium. The anterior portion of the puparium is flattened, and the pupa does not extend to the end in this region. The cephalopharyngeal skeleton is left attached to the inner surface of the larval skin. The tracheæ coming from the anterior spiracles are broken off, so that they do not connect with the pupa. This is apparently true also of the tracheæ leading from the posterior spiracles.

The pupa itself is inclosed in a very delicate white membrane, which is left behind when the adult emerges. A few days after pupation the eyes become pinkish, and gradually deepen in color, becoming red as in the imago just before emergence. The legs, wings, and bristles develop in characteristic positions, that are occasionally retained in part after emergence. Familiarity with these is valuable in carrying out genetic experiments. A description of them is accordingly presented.

The condition of the wings at the time the adult emerges is shown in figure 5, and needs no description.

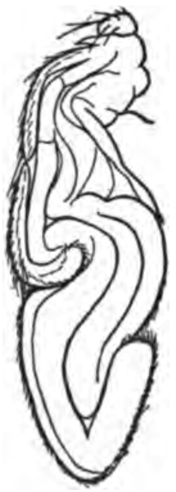


FIG. 5.—Wing of a newly emerged Drosophila simulans, that has not yet unfolded.

The front femora are twisted through 360° near their bases. The other leg segments are straight. The coxæ all point posteriorly, the femora anteriorly, and the tibiæ and tarsi again posteriorly. The legs thus lie closely and compactly against the ventral surface of the developing imago. The twist in the front femora is straightened at or before emergence, and is difficult to see, because it is apt to be lost when an old pupa is dissected unless the operation be done very carefully and examination made quickly.

The bristles do not all point in the same directions as in the fully expanded adult fly. The anterior orbitals point forward, the two posterior ones backward and slightly outward, the tip of the longer one lying over the eye. The postverticals and inner verticals point inward, lying flat on the vertex. The outer verticals point outward, parallel to the edge of the eye. The dorsocentrals point backward and slightly inward, in such fashion as not to cross each other or the anterior scutellars. The humerals, presuturals, and anterior supra-alars point nearly straight backward. The anterior scutellars, postalars, posterior supra-alars, and posterior notopleurals point backward and inward, making an angle of about 45° with the dorsocentral lines. The anterior notopleurals point a little less inward than this. The posterior scutellars point forward and inward, crossing near their bases, and have their apices between the levels of the anterior and posterior pairs of dorsocentrals.

The length of the "horns" (anterior spiracles) in proportion to the length of the rest of the puparium differs according to the species. I have estimated this relation roughly in the following forms (the fraction represents $\frac{\text{length spiracle}}{\text{length puparium}}$):

Chymomyza procnemis	1/12	Drosophila immigrans	1/2
Mycodrosophila thoracis	1/4	D. melanogaster	1/6
Scaptomyza adusta	1/8	D. quinaria	1/8
Drosophila busckii	1/5	D. robusta	2/5
D. funebris	1/5	D. simulans	1/6

In the case of *C. procnemis* there is practically no stalk to the spiracle; in the others this estimate counts the definite stalk that is present as a part of the horn.

The puparia of the four genera named above are all of the same general type. I have also seen puparia of *Leucophenga varia*, and these are like the usual type.

The adult emerges from the puparium through an opening that it forces at the anterior end. A lid is lifted up, the anterior spiracles being on the anterior corners of it. The splits along the sides of the puparium extend as far back as the end of the flattened area at the anterior end of the puparium. Emergence is accomplished by the aid of the *ptilinum*. This is a sac-like structure on the head, just above the bases of the antennæ, that is alternately expanded to a size almost equal to that of the rest of the head, and then contracted until it is scarcely visible. The insect appears to use this structure as a sort of pump, by means of which it drags itself slowly out of the puparium. After emergence the ptilinum is contracted, and in the fully hardened imago it can not be seen.

Descriptions or figures of puparia have been published by the following authors: Comstock (1893, *Chymomyza amœna* and *Drosophila melanogaster*), Howard (1900, *D. melanogaster*), Unwin (1907, *D. funebris*), Martelli (1910, *D. melanogaster*), Banks (1912, *D. melanogaster*), and Malloch (1915, *Mycodrosophila dimidiata* and *Scaptomyza adusta*).

STRUCTURE OF THE IMAGO.

The following description is limited almost entirely to an account of the chitinous structures. The internal anatomy and the soft parts in general are too imperfectly known to warrant any account of them here.

HEAD.

Several regions of the head are recognized and named, though it is often difficult to distinguish the lines separating them. There is a narrow ring surrounding each eye, known as the *orbit*. This bears the orbital bristles. That part of it bordering the lower portion of the eye is sometimes known as the *gena*. The portion between the upper parts of the orbits, above the bases of the antennæ and below the vertex, is known as the *front*. There is a furrow at its lower edge. Below this furrow, between the anterior portions of the orbits, and above the anterior edge of the oral cavity, lies the *face*. This is usually elevated to form a more or less nose-like *carina* (fig. 6, *c*), situated between the antennæ. Below the face, and separated from it by a furrow, is a narrow plate known as the *clypeus*, which forms the anterior edge of the oral cavity. The posterior surface of the head is called the *occiput*. This part extends somewhat forward on the lower lateral part of the head, to form the posterior portion of the "cheek." In this region it is hairy, while the gena is bare. This peculiarity will serve to distinguish the two plates. The *bucca* is a small plate bounded anteriorly by the face, above by the gena, posteriorly by the occiput, and below by the oral cavity. It bears the vibrissæ or oral bristles at its anterior end, and has a row of bristles or hairs along its lower edge.

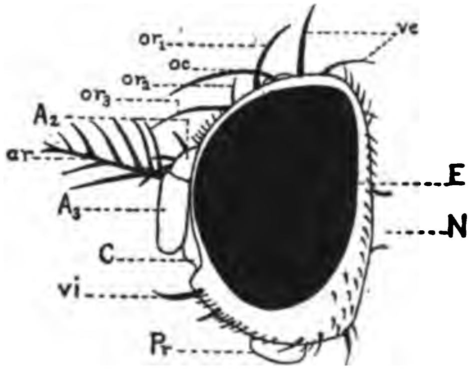


FIG. 6.—Head of Drosophila robusta. A_2, second antennal segment; A_3, third antennal segment; *ar*, arista; *C*, carina; *E*, eye; *N*, neck; *oc*, ocellar bristle; or_1, or_2, or_3, orbital bristles; *Pr*, proboscis; *ve*, vertical bristles; *vi*, vibrissa or first oral bristle.

In the systematic descriptions reference is frequently made to the "greatest width of the cheek." This usually means the length of a line drawn from the lower hind part of the eye to the lower hind corner of the head. Such a line crosses the gena and the occiput. In judging the length of this line it is important that the head be held in a horizontal plane, as the proportions given were all observed when the head was in such a position.

The head bristles of taxonomic value are the following:

Orbitals, or *fronto-orbitals* (fig. 6, *or*): Situated on the orbits, between the vertex and the level of the bases of the antennæ. They are usually three in number: (1) an uppermost one, directed toward the vertex, or "reclinate"; (2) a middle one, also reclinate and usually smaller than the other two; (3) a lowermost one, directed toward the oral cavity, or "proclinate." The third one is situated a little farther from the eye than are the other two.

Ocellars (fig. 6, *oc*): A single pair of bristles situated on the front, just in front of each lateral ocellus and just posterior to the level of the median ocellus. They are directed outwards (are "divergent").

Postverticals: A single pair of bristles, just behind and lateral to the lateral ocelli. They point toward each other (are "convergent").

Verticals (fig. 6, *ve*): Two bristles on each side of the head, at the upper lateral corners of the front. The outer pair is divergent, the inner is convergent.

Vibrissæ, or *oral bristles* (fig. 6, *vi*): Long bristles at the anterior edge of the bucca. These are the conspicuous bristles at the anterior lateral corners of the oral cavity.

ANTENNÆ.

Each antenna is composed of three joints or segments. The first (basal) one is very short, and bears a few short hairs. The second one (fig. 6, A_2) is somewhat longer, and bears a few hairs, of which two to four on the upper surface are perhaps long enough to be called bristles. The third (terminal) joint (fig. 6, A_3) is longer than the other two combined, and is completely covered with small, fine hairs. It bears no hairs or bristles of the ordinary type. Near the base of this third joint arises the *arista* (fig. 6, *ar*). This is a branched, two-jointed structure that probably represents the distal joints of the antenna, present in nematocerous flies. Its basal joint is quite short and somewhat thicker than the long-branched terminal one. The dorsal branches of the latter joint arise at intervals along its entire length; the ventral branches are never present near its base. In addition to these branches, the arista bears a few short, hair-like branches on its inner side.

PROBOSCIS.

The proboscis is of the same type as that of *Musca* (Hewett) or of *Calliphora* (Lowne). There is a basal portion, the *rostrum*, arising from the ventral surface of the head (the oral cavity), and bearing on its anterior portion a *palpus* on each side. The rostrum is shaped like a truncated cone, to the apex of which is attached the *haustellum*. This part, which is roughly cylindrical in shape, is directed forward or downward. It bears on its posterior side a strongly chitinized plate, the *theca*. The *labrum* is a slender, pointed process arising at the angle between the rostrum and the haustellum, and usually lying flat on the dorsal surface of the haustellum. Attached to the apex of the haustellum is a pair of *oral lobes*, one on each side. Within each oral lobe is a series of about ten *pseudotracheæ*. These are tubes that contain numerous chitinized rings, so that they resemble large tracheæ. They probably serve as rasps for grinding particles of food fine enough so that they can be ingested. The palpi are one-jointed structures, covered with hairs similar to those on the third antennal joint; they also bear, distally, several hairs of the ordinary type. The size and shape of the palpi and of their larger hairs vary greatly from species to species.

EYES.

The compound eyes are composed of a large number of *ommatidia*, closely packed together. According to Zeleny and Mattoon (1915), each eye of *D. melanogaster* is made up of about 700 ommatidia. These have hexagonal outlines, as viewed from the surface. At alternate angles of each hexagon there is a minute hair, *i. e.*, each ommatidium has three hairs next to it. The size and color of these hairs is characteristic for each species. In at least some species of *Chymomyza* there is an area of enlarged ommatidia in the lower anterior part of the eye; in general, however, the ommatidia do not differ appreciably in size in any one eye.

The *ocelli*, or simple eyes, are three in number. They are situated near the vertex, between the compound eyes. There is a median anterior one, and a lateral posterior one on each side.

THORAX.

The thorax is made up of three fused segments; *prothorax*, *mesothorax*, and *metathorax*. Each bears a pair of legs, the mesothorax bears the wings, and the metathorax the halteres.

Prothorax: The dorsal aspect of the thorax is made up almost entirely of mesothorax. Only the two anterior lateral angles are prothoracic, and

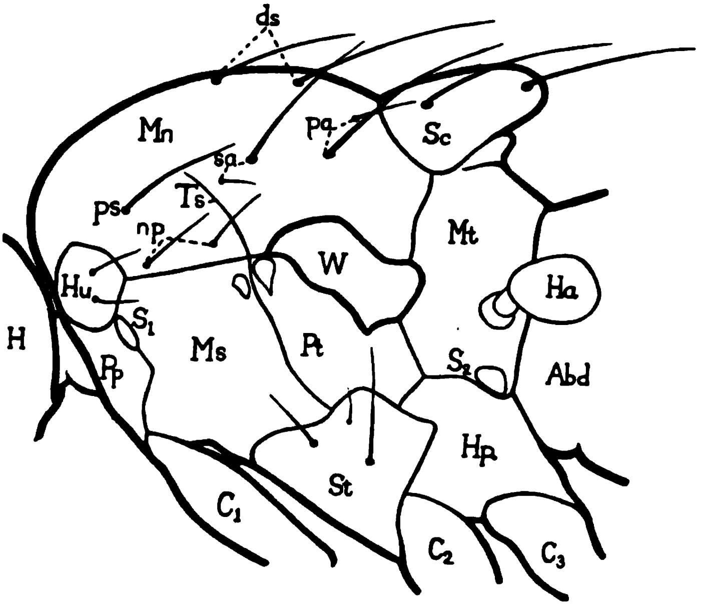


FIG. 7.—Side view of thorax of Drosophila funebris (diagrammatic). *Abd*, abdomen; C_1, C_2, C_3, coxæ; *ds*, dorso-central bristles; *H*, head; *Ha*, haltere; *Hp*, hypopleura; *Hu*, humerus; *Mn*, mesonotum; *Ms*, mesopleura; *Mt*, metanotum; *np*, notopleural bristles; *pa*, postalar bristles; *Pp*, propleura; *ps*, presutural bristle; *Pt*, pteropleura; S_1, S_2, thoracic spiracles; *sa*, supra-alar bristles; *Sc*, scutellum; *St*, sternopleura; *Ts*, transverse suture; *W*, base of wing.

the metathorax is not visible at all from above. These lateral angles appear as small humps, the *humeri* (fig. 7, *Hu*, in side view). Each bears from one to three bristles and a number of hairs. Beneath the humerus, and extending to the base of the coxa of the front leg, lies the *propleura* (fig. 7, *Pp*). This is usually bare, but in a few forms has a single bristle. Several small prothoracic sclerites are visible on the anterior surface of the thorax when the head is removed.

Mesothorax: The greater portion of the dorsal surface of the thorax is made up of the *mesonotum* (fig. 7, *Mn*). On each side of this sclerite is an incomplete *transverse suture* (*Ts*), sometimes referred to simply as the *suture*. Behind the mesonotum lies the *scutellum* (*Sc*), which is roughly triangular in shape as viewed from above, and which overhangs the dorsal surface of the metathorax. The scutellum nearly always bears four marginal bristles, but among the Drosophilinæ is usually without hairs (except in *Curtonotum*). Below the mesonotum and behind the propleura lies the large subquadrate *mesopleura* (*Ms*). This plate is bare, except in such forms as *Curtonotum* and *Camilla*. The suture separating it from the mesonotum is the *notopleural suture*. Behind the mesopleura and below the base of the wing lies the *pteropleura* (*Pt*). It is always bare. Below the mesopleura and pteropleura, and above the coxa of the middle leg, lies the *sternopleura* (*St*). This plate always bears a few bristles on its upper part and a few hairs below. Near the base of the wing there are a number of complex smaller mesothoracic sclerites that I have not worked out in detail.

Metathorax: The dorsal part of the metathorax, as far down as the level of the spiracle, is known as the *metanotum* (fig. 7, *Mt*). Morphologically this is really a complex of several sclerites; but the sutures separating them are obscure, and it is convenient to treat the structure as a unit. Below this plate and above the hind coxa lies the *hypopleura* (*Hp*). These two regions are both usually bare, the only metathoracic bristles being on the hind legs.

The thorax bears two large pairs of *spiracles*. The anterior thoracic spiracle (S_1) lies just below the humerus, between the propleura and the mesopleura. The posterior thoracic spiracle (S_2) lies below the haltere, between the metanotum and the hypopleura.

The thoracic bristles and hairs of taxonomic importance, other than those named for the parts on which they occur, are the following:

Dorsocentrals (fig. 7, *ds*): On the median posterior part of the mesonotum, in front of the scutellum. There are usually two pairs, and they are the conspicuous backward-pointing bristles seen in a dorsal view of the thorax.

Notopleurals (*np*): Two bristles on the mesonotum, just above the notopleural suture.

Presutural (*ps*): Behind the inner angle of the humerus, in front of the transverse suture, and nearer the median line than is the anterior notopleural.

Supra-alars (*sa*): Behind the transverse suture; above and near or anterior to the anterior portion of the base of the wing. Usually a small anterior one and a large posterior one.

Postalars (*pa*): Above the middle of the wing-base, just in front of the scutellum, and lateral to the dorsocentrals. A large anterior one and a small posterior one.

Prescutellars: Between the members of the posterior dorsocentral pair, and at the same level with them. Absent in most members of the genus

Drosophila, but present in *Curtonotum*, *Stegana*, *Leucophenga*, and other genera.

The dorsocentral bristles lie in longitudinal rows of hairs, and in some forms, such as *Drosophila funebris*, *D. repleta*, and *D. hydei*, a few of the hairs in this row anterior to the true dorsocentrals are sometimes enlarged and bristle-like.

Between the dorsocentral rows are several rows of *acrostichal hairs*. The number of these rows is a very convenient taxonomic character. Unless otherwise stated, the count is to be taken just in front of the anterior dorsocentral bristles. Some such convention is made necessary by the fact that the rows are often a little irregular, and are apt to be more numerous in the anterior part of the region than in the posterior.

LEGS.

Each leg consists of nine segments or "joints": the *coxa*, *trochanter*, *femur*, *tibia*, and five *tarsal* joints. The coxa, or basal joint, is articulated to the thorax. It is much longer on the first pair of legs than on the second or third. The trochanter is very short. The femur and tibia are both long joints, clothed with hairs and bristles. Most important taxonomically among the latter are the *apical* and *preapical* bristles of the tibiæ, situated in the positions indicated by their names. The five tarsal joints are all short, the basal one being the longest. At the apex of the distal tarsal joint is situated a pair of minute curved black *claws*. Beneath each claw is a minute white pad-like *pulvillus*.

WINGS.

The veins and cells of the wing of *Drosophila melanogaster* are shown in figure 8, and need not be described in detail.

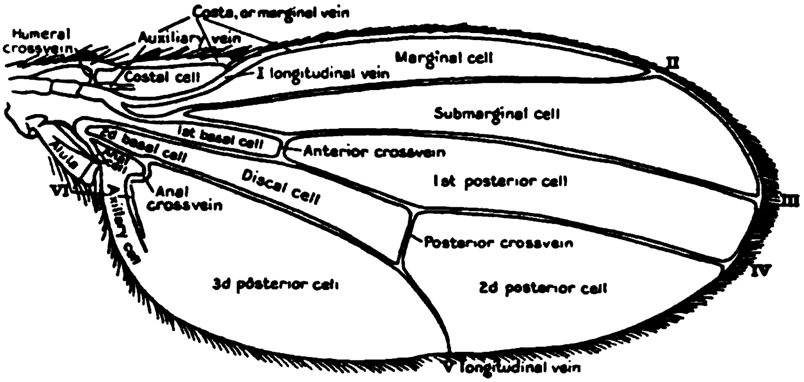


FIG. 8.—Wing of Drosophila melanogaster. The parts are named on the diagram itself.

Two costal breaks are to be seen; the proximal, just beyond the humeral cross-vein, and the distal, just before the apex of the first vein.

The portion of the costa proximal to the apex of the first vein is known as its first section; that between the apices of the first and second veins as its second section, etc. The portion of the fourth vein lying between the anterior and posterior cross-veins is known as its third section. The division-point between the first and second sections is the junction between the fourth vein and the cross-vein (absent in *Drosophila*) that separates the second basal and discal cells. The relative lengths of the sections of these veins are of taxonomic importance, and are expressed by the following indices:

Costal index: Length of second section of the costal vein divided by length of its third section.

Fourth-vein index: Length of fourth (distal) section of the fourth vein divided by length of its third section.

4c index: Length of third section of costal vein divided by length of third section of fourth vein.

5x index. Length of third (distal) section of fifth vein divided by length of posterior cross-vein.

The costal vein, up to a point between the apices of the third and fourth veins, bears on its outer surface a series of short black hairs. On the first costal section these hairs form a double row; on the second and third sections there is only a single row. Just before the distal costal break there is a larger pair of bristle-like hairs (in *Mycodrosophila* and in *Drosophila immigrans* there is only a single bristle here). The surface of the wing is covered with much smaller pale hairs that are discernible only under considerable magnification. These small hairs are missing in a narrow band that marks the position of the lost cross-vein that, in some forms, separates the discal and second basal cells.

McEwen (1918) has figured the small (sensory?) organs that occur on the wing-veins of *Drosophila melanogaster*. These are minute ring-shaped structures. There is a group of them near the base of the wing, on the common base of the first, second, and third veins. Seven larger ones occur farther out on the wing, as follows: two at the junction of the first and costal veins, one near the base of the third vein, one near the middle of the anterior cross-vein, and three on the distal section of the third vein, dividing it into three subequal proximal portions and a slightly longer distal one. The last three organs mentioned are attached to the posterior surface of the third vein, *i. e.*, to the surface facing the fourth vein. The other four organs are on the upper surfaces of the veins.

Examination of balsam mounts of 22 species of *Drosophila*, two of *Scaptomyza*, and one each of *Aulacigaster*, *Curtonotum*, *Zygothrica*, *Zaprionus*, *Leucophenga*, *Chymomyza*, and *Mycodrosophila*, shows that the number and distribution of these organs on the main part of the wing is rather constant. The organ on the basal section of the third vein is often near the middle of that section, and in *Drosophila inversa* lies very close to the anterior cross-vein. The three organs on the distal section of the third vein vary somewhat in their positions relative to each other and to the ends of this section of vein. The greatest difference in this respect occurs in *Aulacigaster leucopeza*, where all three organs are in the distal three-fifths of the section. In *Aulacigaster* and in *Curtonotum* it is clear that the two organs near the junction of the first and costal veins really lie on the first vein. The only really striking variation in these organs that I have found occurs in *Drosophila guttifera*. This species has several pigmented areas on the wings, and each of these includes either the junction of two veins or else an organ of the type here under discussion. One of the latter is on the posterior surface of the penultimate section of the fifth vein—the only case in the group where I have found more than the usual 7 organs on the main part of the wing.

The same 7 organs occur in the same general positions in the extra-drosophiline genera *Calliphora*, *Fucellia*, *Ensina*, *Chætopsis*, *Camptoneura*, *Ochthiphila*, *Phytomyza*, *Diastata*, *Piophila*, *Sepsis*, and *Mallochiella*. *Dolichopus*, however, has only 5.

Behind and just below the base of the wing proper there is a small continuation of the membrane of the wing, lying close against the surface of the thorax. This structure, called the *calypter*, *squama*, or *tegula*, is fringed with fine hairs.

HALTERES OR BALANCERS.

The hind wings of the Diptera are represented by small organs, known as balancers or halteres, that lie below and behind the bases of the true wings (fig. 7, *Ha*). In the Drosophilinæ they are whitish, flask-shaped bodies. Each consists of three segments—a short basal one, a somewhat larger roughly cylindrical middle piece, and a large terminal pear-shaped one.

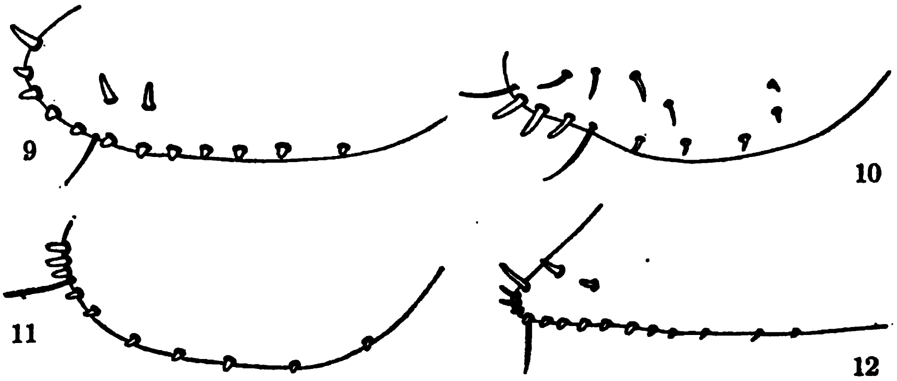
There is a mutant race of *Drosophila melanogaster*, known as "bithorax," in which the metathorax resembles the mesothorax more or less closely. As a part of this change, the halteres are often somewhat wing-like. In some cases the black hairs that occur on the costal margin of the wing are present, and a fairly definite wing-blade with a few veins can be distinguished. Numerous types intermediate between this stage and the normal haltere can be found. An examination of these specimens indicates that the constrictions between the three segments of the haltere correspond, respectively, to the proximal and distal costal breaks of the wing.

The halteres of the Diptera generally probably contain organs that enable the insect to orient to gravity when in flight. Hewett states that in the house-fly they receive the largest of the thoracic nerves.

ABDOMEN.

The abdomen consists of seven visible segments in the female, five in the male. The dorsal and lateral surface of each of these is composed of a heavily chitinized *dorso-lateral plate*, and these are telescoped together, so that the posterior portion of each one overlaps the anterior portion of the one behind it. The first segment is probably morphologically really two segments fused together. It possesses a deep transverse furrow, but this is probably secondary, and does not correspond to the line of fusion of the two segments. Each of the dorso-lateral plates is clothed with hairs and bristles.

Ventrally the abdomen bears a series of chitinized plates, separated from the dorso-lateral plates by a parchment-like region. These *ventral plates* are hairy, and quadrilateral in shape. In the female they are six in number. The five anterior ones are much alike in shape, but the posterior one is narrower and has a deep notch in its posterior side. Only four ventral plates are to be seen in the male. The three anterior ones are like those of the female; the posterior one is much larger and broader than the others.



OVIPOSITOR PLATES.

FIG. 9.—Scaptomyza adusta.
FIG. 10.—Scaptomyza graminum.
FIG. 11.—Drosophila melanogaster.
FIG. 12.—Drosophila virilis.

In the female the sixth and seventh dorso-lateral plates are smaller than the first to fifth ones. In pinned material they are usually retracted, so that there appear to be five segments like those of the male. In life or in cleared specimens the sixth plate can be seen to be quite narrow and weakly chitinized above (in the mid-dorsal region), but relatively broad and strongly chitinized below. The seventh plate, on the other hand, is broad and strongly chitinized above, and narrow and weakly chitinized below.

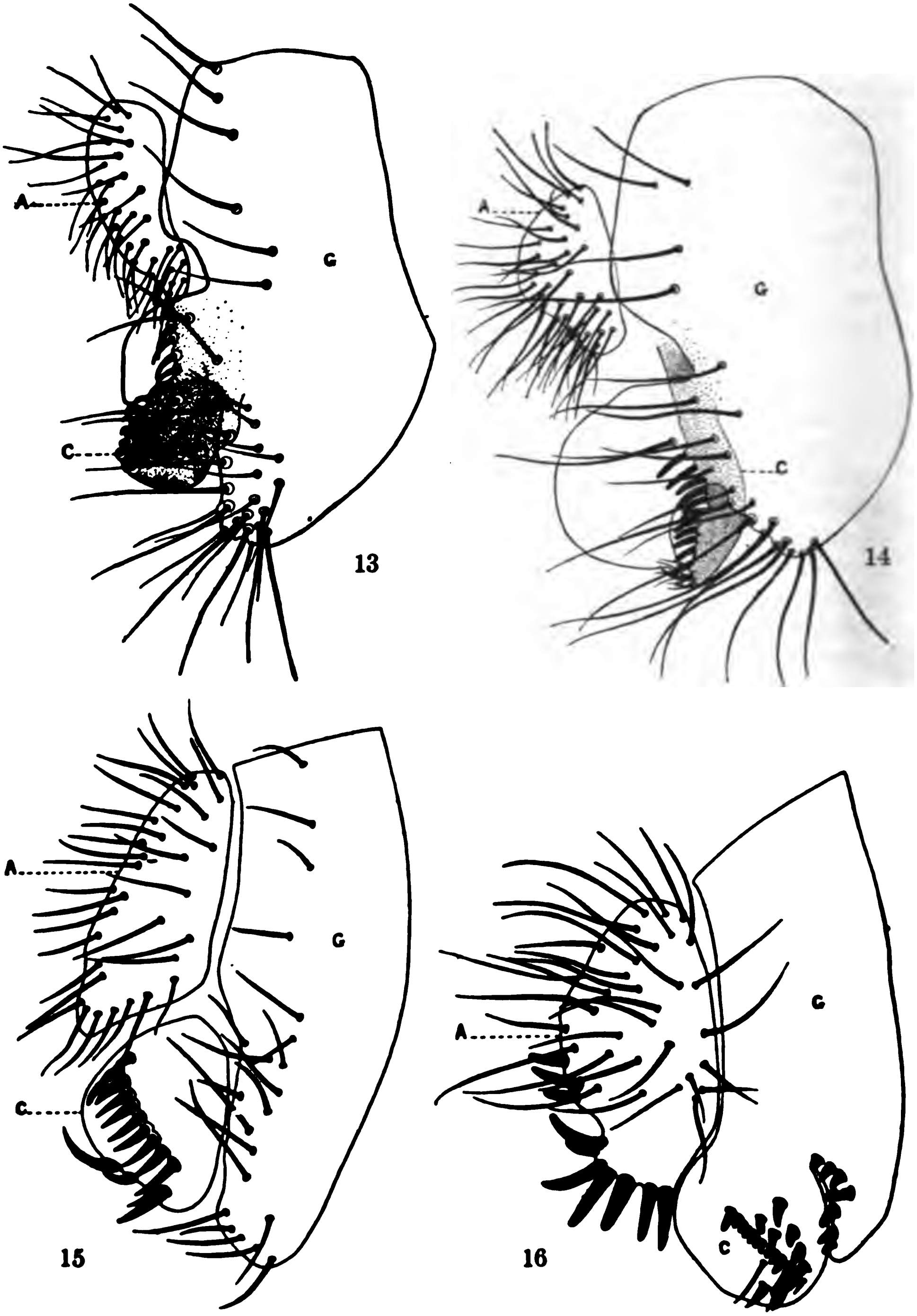
Abdominal spiracles: There are seven spiracles on each side of the abdomen. Two of these lie just under the lower edge of the first dorso-lateral plate. The second to fourth dorso-lateral plates, inclusive, have one apiece just beneath their edges. In the female there is one in the same position with respect to the fifth plate, and one on the sixth plate itself, just above its lower edge. In the male there are two just above the lower edge of the fifth plate, suggesting that this plate, like the first, really represents two fused segments. All these spiracles appear as minute round holes, with tracheæ connected to them and indistinctly visible through the body-wall.

Genital region, female: Behind the seventh dorso-lateral plate of the female are situated the anal and genital openings. The anal opening, above, is on a papilla composed of a long-haired dorsal and a similar ventral chitinized plate. Just below this papilla is the ovipositor. This organ consists of two similar lateral chitinized plates that bear numerous small peg-like hairs or bristles and one or a few longer and more slender hairs. A few characteristic plates are shown in figures 9 to 12.

Genital region, male: Behind the fifth dorso-lateral plate of the male is situated a small plate that is very difficult to study. It probably represents the dorso-lateral plates of one or more abdominal segments. Behind this lies a definite but small dorso-lateral plate that I have arbitrarily designated the *genital arch.* Characteristic types are shown in figures 13 to 16. Below and behind this structure lies a small structure that we may call the *clasper.* It appears in many diverse forms, and has various relations to the genital arch, but almost always bears peg-like bristles. In *Drosophila melanogaster* (fig. 13) and in *D. simulans* (fig. 14) it is weakly chitinized at its base, which articulates to the inner surface of the genital arch. In *D. busckii* (fig. 15) it is separate from the genital arch and lies directly behind it. In *D. funebris* (fig. 16) it is fused to the lower posterior edge of the genital arch.

The *anal plates* are upright and lie on each side of the anus, instead of above and below it, as in the female. They are always hairy, and sometimes bear peg-like bristles, as in *D. funebris* (fig. 16). In *D. caribbea* there is an especially large bristle of this type on the lower corner of each plate. In *D. repleta* and some other species the anal plate is connected to the genital arch by a chitinous bridge.

These same three plates occur, with various modifications but in the same general relations to each other, in *Curtonotum gibbum, Zygothrica dispar, Pseudophortica obesa, Leucophenga varia, Mycodrosophila dimidiata, Scaptomyza adusta, S. graminum,* and over a dozen species of *Drosophila* that I have examined. In *Curtonotum helva,* however, there is an extra clasper. The usual clasper is present as a slender plate tapering to its apex, and inserted as in *D. melanogaster.* The other clasper is a slender, club-shaped structure, attached to the outer surface of the genital arch, near its posterior edge and just below the anal plate. This is evidently the structure known as the posterior clasper in the Calypteræ; and the other organ, that is



EXTERNAL MALE GENITALIA. *A*, anal plate; *C*, clasper; *G*, genital arch.

FIG. 13.—Drosophila melanogaster.
FIG. 14. Drosophila simulans.
FIG. 15.—Drosophila busckii.
FIG. 16.—Drosophila funebris.

the only clasper present in most Drosophilinæ, must be the anterior clasper of the Calypteræ.

The three plates just discussed—the genital arch, the clasper, and the anal plate—together with the soft parts around them, form what is known as the *hypopygium*. These plates furnish extraordinarily certain and definite specific characters, but can not be studied satisfactorily except in cleared or dissected material. I have therefore avoided their use, except in the case of *Drosophila melanogaster* and *D. simulans*. In this case I have been unable to discover any more convenient character for separating the two species. Their use will undoubtedly be necessary when a satisfactory treatment of the genus *Chymomyza* is worked out.

Internal genital apparatus, male: The penis is a chitinized tube, differing greatly in shape from species to species. It can be extruded through the genital opening, between the lower ends of the genital arch. In the genus *Curtonotum* it is long and strongly curved, suggesting the coiled penis of the Trypetinæ. Within the body lie other chitinized parts connected with the penis, but I have not made out their nature and detailed structure.

The *testes* are usually cylindrical and coiled, but are ellipsoidal in *Drosophila obscura*. They are usually bright-colored—reddish-orange to yellow, according to the species. In the adult male of most members of the group the testes contain chiefly fully formed spermatozoa.

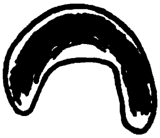
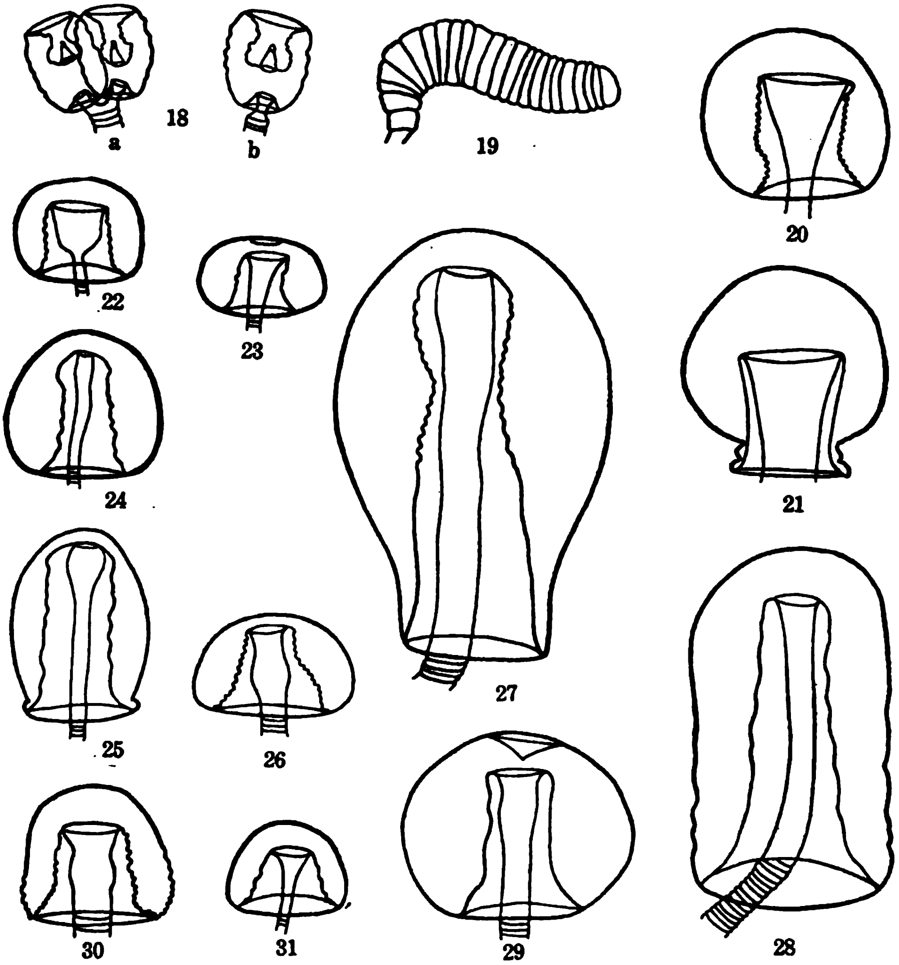


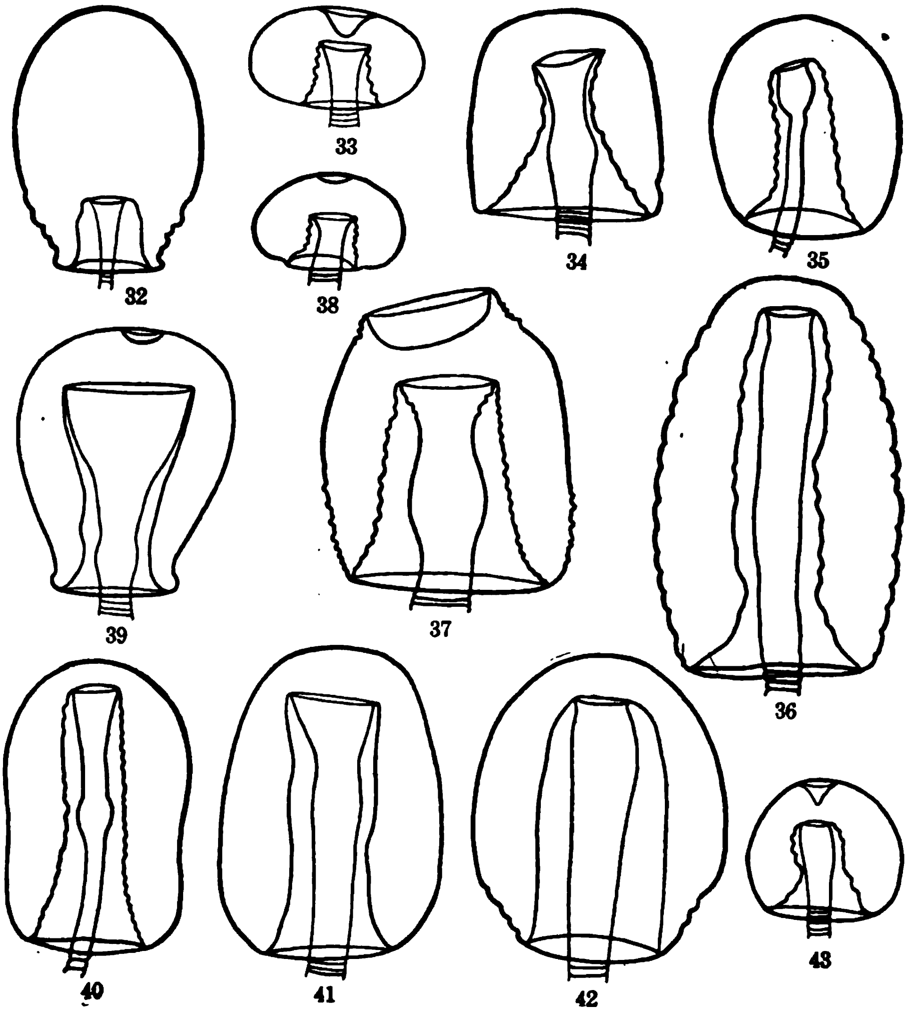
FIG. 17.—Oblique section through spermatheca of Drosophila obscura, showing sperm inside.

Internal genital apparatus, female: In the abdomen of the female are to be found small chitinized *seminal receptacles* or *spermathecæ* (figs. 18 to 43). The figures will give an idea of the types that occur. Leading from each receptacle is a trachea-like tube that opens into the oviduct. Figure 17 shows an oblique section through a spermatheca that is filled with spermatozoa. The number of these receptacles is two in all but two of the drosophiline species that I have examined. These include one species each in the genera *Curtonotum, Zygothrica, Zaprionus, Leucophenga,* and *Mycodrosophila,* two each in *Scaptomyza* and *Chymomyza,* and 22 in *Drosophila* (including such widely divergent forms as *D. busckii, D. guttifera, D. immigrans, D. nebulosa,* and *D. saltans*). Among these 31 species the only strikingly different types of receptacles found were in *Leucophenga varia* (fig. 19), and in *Curtonotum gibbum,* in which they are narrow, smooth, and cylindrical. The two exceptions to the rule that two chitinized receptacles are present are *Drosophila inversa,* in which I have been unable to find any at all, and *Aulacigaster leucopeza* (fig. 18), in which three are present. As the figure shows, these are of a somewhat unusual type; and two of them are attached to a single duct. This is normal for the species, as it has been observed in specimens from Alabama and also from Illinois.



FIGS. 18–31.—Spermathecæ. Magnified 250 diameters. 18. Aulacigaster leucopeza. 19. Leucophenga varia. 20. Chymomyza amœna. 21. Mycodrosophila dimidiata. 22. Scaptomyza graminum. 23. Drosophila affinis. 24. Drosophila busckii. 25. Drosophila caribbea. 26. Drosophila duncani. 27. Drosophila funebris. 28. Drosophila guttifera. 29. Drosophila immigrans. 30. Drosophila melanica. 31. Drosophila melanogaster.

According to Wesché (1906), most of the non-muscid Diptera have three chitinized receptacles with three separate ducts, although none is seen in the Dolichopodidæ, Lonchopteridæ, and Phoridæ, and only one in the Simuliidæ and Empididæ. Among the calypterate Muscidæ three is again the rule, though only two are found in the Stomoxyiinæ. Among the Acalypteræ the numbers range from 0 to 4. I have myself examined several extra-drosophiline genera. These, with the forms described by Wesché, may be tabulated as in table 2.



Figs. 32–43.—Spermathecæ. Magnified 250 diameters. 32. Drosophila nebulosa. 33. Drosophila obscura. 34. Drosophila putrida. 35. Drosophila quinaria. 36. Drosophila repleta. 37. Drosophila robusta. 38. Drosophila saltans. 39. Drosophila similis. 40. Drosophila transversa. 41. Drosophila tripunctata. 42. Drosophila virilis. 43. Drosophila willistoni.

The receptacles of *Lonchæa polita* Say (Lonchæinæ) and of *Scatophaga stercoraria* Linnæus (Cordylurinæ) resemble those of *Leucophenga varia*. The telescoped type of receptacle so common among the Drosophilinæ occurs also in *Scatophaga* (Cordylurinæ), and apparently in *Parydra* (Ephydrinæ). The two receptacles of *Chiromyia minima* Becker (Geomyzinæ) are similar in structure to those of *Aulacigaster leucopeza*.

TABLE 2.

0	1	2	3	4
Chloropinæ. Drosophilinæ.	Ephydrinæ.	Agromyzinæ. Borborinæ. Drosophilinæ. Geomyzinæ. Lonchæinæ. Ortalinæ. Sciomyzinæ. Trypetinæ.	Borborinæ. Drosophilinæ.[1] Ochthiphilinæ. Ortalinæ. Phycodrominæ. Lauxaniinæ. Sepsinæ.	Geomyzinæ. Helomyzinæ. Ortalinæ.[1]

[1] *Aulacigaster* (3 receptacles) and *Seoptera* (4 receptacles) each have only two ducts.

The *ovaries* consist of five or more egg-strings each. At the anterior end of each string lie the oogonial cells; at the posterior end is a mature egg. The region between is filled with eggs in intermediate stages of development. After oogonial multiplication has been completed there are found to be cysts of oogonial cells surrounded by follicular envelopes. Each cyst contains 16 nuclei, of which one becomes the egg-nucleus and the other 15 belong to nurse-cells. These 16 nuclei are alike to all appearances until a relatively late stage.*

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* This account of the ovary is from Plough (1917).

Since this paper was sent to press J. F. Nonidez (1920. Biol. Bull. 39: 207–230) has published a full account of the structure and physiology of the internal genital apparatus of both sexes of *Drosophila melanogaster*.

VII. CHROMOSOMES.

The chromosomes of various species of Drosophilinæ have been studied by Miss Stevens (1908), Bridges (1916), and Metz (1914, 1916). The two most striking general facts brought out by these studies are, first, that as a rule division figures are more easily obtained in ovarian tissue than in testicular; and second, that the two members of each pair of chromosomes commonly lie side by side at all cell divisions. This latter characteristic is found in most, if not all, other Diptera as well as in the Drosophilinæ.

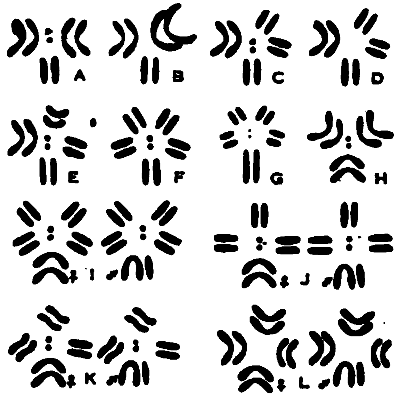

FIG. 44.—Diagram of chromosome groups found in the Drosophilinæ (after Metz).

Metz has described and figured the chromosome groups of a large number of species of the subfamily. He recognizes twelve different types, which are shown in figure 44, a diagrammatic representation made by Metz. The various types are represented by the following species:

- Type A. Chymomyza amœna.
  - C. procnemis.
  - Mycodrosophila dimidiata.
  - Scaptomyza graminum.*
  - Drosophila busckii.
  - D. bromeliæ.
  - D. floræ.
  - D. melanogaster.*
  - D. nebulosa.
  - D. quinaria.
  - D. robusta.
  - D. saltans.
  - D. willistoni.
- Type B. Drosophila earlei.
- Type C. Scaptomyza adusta.*
  - Drosophila calloptera.*
- Type D. Drosophila immigrans.
- Type E. Drosophila melanica.
- Type F. Drosophila cardini.
  - D. ramsdeni.
  - D. repleta (hydei?).
  - D. similis.
  - D. tripunctata.
  - D. virilis.
- Type G. Drosophila funebris.
- Type H. Cladochæta nebulosa.
- Type I. Drosophila mulleri.
- Type J. Drosophila obscura.
- Type K. Drosophila affinis.
- Type L. Drosophila caribbea.

In types I, J, K, and L the male and female groups are both shown, and these obviously differ with respect to one pair—the sex chromosomes. In the other types only the female groups are shown. In those species belonging to types A and C that are marked with an asterisk (*), male chromosome-groups have been studied and found to differ from the female groups in such manner as to show that the rod-like pair of chromosomes represented at the bottom of the diagrams is the sex-chromosome pair. Male groups in *D. virilis* (type F) and *D. funebris* (type G) suggest that the long pair represented at the bottom in these figures is the sex-chromosome pair, but the differences between the two members are not striking enough to make this conclusion certain.

It appears from the studies of Metz and Stevens that the usual muscid chromosome group is quite different from these. It consists of six pairs of chromosomes, of which five are more or less V-shaped, while the sixth and smallest is a short rod or is spherical and is the sex-chromosome pair. This group has been found in numerous calypterate muscids, and in the following acalypterate genera:[*]

Piophilinæ—Piophila.
Ortalinæ —Camptoneura.
Trypetinæ—Euaresta(?).
Lauxaniinæ —Physogenua.
Sciomyzinæ —Tetanocera, Neuroctena.
Cordylurinæ—Scatophaga.

The only muscid not a drosophiline that has been found to have a chromosome group different from this is *Chætopsis fulvifrons* Macquart, one of the Ortalinæ. Metz finds that this species has a chromosome group like that of type A, figured above, though it is not known which is the sex-chromosome pair. The interpretation of these data will be obscure until Geomyzinæ, Milichiinæ, or Ephydrinæ are studied. Here, if anywhere, one might expect to find intermediate stages in the series.

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[*] In a few of these it has not been definitely determined that the smallest pair is the sex-chromosome pair.

VIII. INTRASPECIFIC VARIABILITY.

The species of Drosophilinæ, as they occur in the wild state, are as a rule not strikingly variable. They do vary in size or in intensity of color as a result of the amount of food obtained in the larval stage. Especially striking examples of this sort of modification are furnished by *D. cardini* and *D. funebris*, in both of which breeding experiments have shown that the variations are not inherited. But real inherited variations seem not to be common. Slight variations in the abdominal pattern of such forms as *D. busckii*, *D. transversa*, and *Mycodrosophila dimidiata* are probably of a genetic nature, and the variations in the intensity of the slight "trident" mark that is often present on the mesonotum of *D. melanogaster* have been shown to be inherited. I have studied an inherited variation in mesonotal pattern in *D. repleta* that occurs in wild flies (Sturtevant 1915). A number of investigators have shown that the occasional extra dorsocentral bristles found in wild stocks are in some cases heritable. Miss Hoge (1915) found inherited differences in the number of teeth in the tarsal combs of wild *D. melanogaster* males. Although it is not uncommon to find individual wild specimens that contain mutated genes, I know of no cases in the group other than those just mentioned in which a variation is established in nature and can be found persisting side by side with the parent stock.

There are certain measurable characters in which the various species show variability, which may be heritable or not. Since most of these characters are used taxonomically, it becomes of interest to know just how variable they are, and what are the limits for different species. Unless this information is at hand it is not possible to judge as to their value as diagnostic characters. The following data bear on this point:

The possession of two pairs of dorsocentral bristles is characteristic of the Drosophilinæ. Four pairs are present in *Blæsochætophora* and *Dettopsomyia;* one in *Acletoxenus* and *Drosophila superba*, and only one large pair in *Mycodrosophila;* aside from these forms two pairs occur in all the forms known to me. The same number is to be found in many other Acalypteræ, scattered through most of the subfamilies. It is especially common in the Sciomyzinæ, Geomyzinæ, and Milichiinæ, but in none of the other subfamilies is it as usual as in the Drosophilinæ. In species where two pairs are the rule, however, exceptional individuals can often be found. I have examined a large number of specimens of several species for this character, with the result shown in table 3. The numbers given refer to the total number of dorsocentrals present. Two pairs, for example, equal "4." The flies recorded in these tables were all bred on banana agar under laboratory conditions. The numbers from each stock are based on examinations of individuals from several cultures made at different times, so that accidental environmental differences have been reduced to a minimum. Table 4 gives the results of a statistical treatment of the totals for the three species *D. immigrans*, *D. melanogaster*, and *D. simulans*. A comparison of the coefficients of variation (V) shows that *D. immigrans* is more than 100 times as variable for this character as is *D. simulans*. *D. melanogaster* is only slightly less variable than is *D. immigrans*. The other species, for which little data are available, have not been worked out in statistical form.

TABLE 3.—*Frequencies of various numbers of dorsocentrals.*

Stock from—	3		4		5		6		Total.	Extras per 100 flies.
	♀	♂	♀	♂	♀	♂	♀	♂		
Drosophila immigrans:										
Norway	0	0	109	153	2	0	0	0	264	0.8
Attleboro, Mass.	0	0	84	103	0	0	0	0	187	0.0
White Plains, N. Y.	0	1	75	64	2	1	0	0	143	2.1
Staten Island, N. Y.	1	1	89	114	4	1	2	1	213	5.2
Staten Island (No. 2)	0	0	72	64	1	0	0	0	137	0.7
Arlington, Md.	0	0	105	102	5	2	2	0	216	4.2
Lakeland, Fla.	1	0	103	124	12	4	4	0	248	9.7
Total	2	2	637	724	26	8	8	1	1,408	3.7
Drosophila melanogaster:										
Randolph, N. H.	0	0	182	140	9	3	0	0	334	3.6
Falmouth, Mass.	0	0	100	101	6	4	1	1	213	6.6
White Plains, N. Y.	0	1	128	147	2	0	0	0	278	0.7
Baltimore, Md.	0	0	185	144	1	0	0	0	330	0.3
Camp Jackson, S. C.	0	0	112	143	2	1	1	0	259	1.9
Rochester, Minn.	0	0	116	94	1	0	0	0	211	0.5
Berkeley, Cal.	0	0	115	81	0	1	0	0	197	0.5
Lakeland, Fla.	0	0	176	170	1	1	0	0	348	0.6
Total	0	1	1,114	1,020	22	10	2	1	2,170	1.8
Drosophila simulans:										
Cold Spring Harbor, N. Y.	0	0	97	86	0	0	0	0	183	0.0
Staten Island, N. Y.	1	0	116	79	1	0	0	0	197	0.5
Rochester, Minn.	0	0	73	108	0	1	0	0	182	0.5
Kushla, Ala.	0	0	64	84	0	0	0	0	148	0.0
Lakeland, Fla.	0	0	143	115	1	0	0	0	259	0.4
Total	1	0	493	472	2	1	0	0	969	0.3
Drosophila affinis:										
New York, N. Y.	0	0	101	60	1	1	0	0	163	1.2
Drosophila busckii:										
Norway	0	1	91	71	0	0	0	0	163	0.0
Chymomyza procnemis:										
Lakeland, Fla.	0	0	50	55	0	0	0	0	105	0.0

TABLE 4.—*Statistical constants derived from table 3.*

(M = mean; σ = standard deviation; V = coefficient of variation.)

Species.	M	σ	V
D. immigrans	4.034 ± 0.034	0.228 ± 0.003	5.66 ± 0.013
D. melanogaster	4.016 ± .003	.146 ± .002	3.63 ± .037
D. simulans	4.002 ± .00004	.002 ± .00003	.05 ± .0008

The wing-vein indices, though known to be variable, nevertheless offer valuable aids in the identification of species. How variable they are may be gathered from the data in tables 5 and 6, which show the results obtained from measurements of *D. melanogaster* from a number of different sources, and of *D. melanica* from Massachusetts.

TABLE 5.—*Fourth-vein index, D. melanogaster.*

Index.	No. of individuals.	Index.	No. of individuals.	Index.	No. of individuals.
2.0	2	2.5	4	2.9	1
2.1	7	2.6	7	3.0	0
2.2	16	2.7	4	3.1	0
2.3	19	2.8	1	3.2	1
2.4	8				

Total No., 70. $M = 2.353 \pm 0.017$; $\sigma = 0.213 \pm 0.012$; $V = 9.08 \pm 0.58$.

TABLE 6.—*Indices of D. melanogaster and D. melanica.*

Melanogaster.				Melanica.			
Costal index.	No. of individuals.	5x index.	No. of individuals.	Costal index.	No. of individuals.	Fourth-vein index.	No. of individuals.
1.9	1	1.6	1	2.9	1	1.5	1
2.0	2	1.7	0	3.0	0	1.6	3
2.1	2	1.8	1	3.1	0	1.7	5
2.2	1	1.9	1	3.2	1	1.8	3
2.3	1	2.0	1	3.3	4		
2.4	1	2.1	1	3.4	1		
2.5	2	2.2	1	3.5	0		
		2.3	1	3.6	1		
		2.4	0	3.7	1		
		2.5	1				
Total....	10	....	8	Total....	9	....	12

The number of branches on the antennal arista is usually given as a specific character. It is also variable, as shown in table 7. In this table the terminal portion of the main axis is counted as a branch, so that an arista described as having five branches above and three below would be entered here under "9."

TABLE 7.—*Variation in number of aristal branches.*

Species.	Source of stock.	6	7	8	9	10	11	12	Total.
D. melanogaster............	Camp Jackson, S. C......	0	0	3	55	22	0	0	80
	Berkeley, Cal...........	0	0	17	20	3	0	0	40
D. immigrans..............	Arlington, Md...........	0	0	4	28	36	4	0	72
D. funebris................	Ann Arbor, Mich........	0	0	0	1	12	17	10	40
D. repleta.................	New York, N. Y.........	0	12	6	0	0	0	0	18
D. hydei...................	Lakeland, Fla...........	1	13	2	0	0	0	0	16

Statistical constants for *D. melanogaster*, both races taken together:
$M = 9.042 \pm 0.038$; $\sigma = 0.610 \pm 0.027$; $V = 6.74 \pm 0.29$.

SECONDARY SEXUAL CHARACTERS.

In general, the two sexes of drosophiline flies are quite similar in appearance, but secondary sexual characters can nevertheless often be found. The following is only a partial catalogue of such sexual differences, and includes only the more striking differences and the less conspicuous ones that occur on the commoner forms.

Sex-combs: A comb-like row of about ten short, stiff, slightly curved black bristles occurs on the inner distal surface of the basal tarsal joint of the front leg in the males of some species. I have never seen such a comb in a female. It is invariably present in the males of *Drosophila melanogaster* (see plate 3, fig. 2), *D. simulans*, *D. affinis*, the European *D. confusa* Staeger, and an undescribed South American species that is very similar to *D. nebulosa*. In *D. obscura* a somewhat smaller comb is present in this position, and a second one occurs on the second tarsal joint of the front leg (see fig. 47). Here also the female has no tarsal combs.

Other leg characters: The male of *D. immigrans* has the two basal joints of his front tarsus distinctly shorter and thicker than the corresponding joints of the other legs. In the female all the tarsi are similar in size and shape. In the genus *Chymomyza* (all the species known to me) the males have a row of long, stiff bristles on the lower side of the front femur. These bristles are either missing or much smaller in the females. As suggested above, this sexual difference may be correlated with the peculiar mating habits of this genus. According to Oldenberg (1914, p. 9) there is a sexual difference in the shape and hairiness of the tibiæ and tarsi in the European *D. nigrosparsa* Strobl.

Shape of head: In *Zygothrica dispar* the males have very broad heads, with the eyes conically produced. This character apparently never occurs in the females, and even in the males it is quite variable. I have seen one male in which the head was not broader than is usual for the female.

According to Oldenberg (1914), some species of *Stegana* resemble the Calypteræ in that the males have a narrower front than do the females. The same is true of Hendel's genus *Thaumastophila* (see *Apsinota*).

Color: In the genus *Leucophenga* generally the males are paler in color than the females, and have more whitish pollinosity. There is a sexual dimorphism in mesonotal color in the Oriental *Drosophila hypocausta* Osten Sacken and in the Ethiopian *D. aberrans* Lamb. According to Oldenberg, sexual differences in thoracic color occur in *Acletoxenus* and in *Phortica*. I have observed such differences in *Zygothrica*.

In many species of *Drosophila* the dark abdominal bands are broader in the male than in the female. In such forms as *D. melanogaster*, *D. simulans, D. funebris, D. obscura, D. affinis,* and *D. cardini* this difference is quite well marked.

Size: In most species the males average a little smaller than the females. In the case of *D. melanogaster* this size difference is a true secondary sexual character, as has been shown by an examination of a large series of gynandromorphs (Morgan and Bridges, 1919). In these specimens male and female parts are combined in the same individual; and it is regularly observed that the male parts are a trifle smaller and bear somewhat smaller bristles and hairs. I have observed the same relation in gynandromorphs of *D. simulans.*

Abdominal structure: As has been pointed out above, the abdominal structure of the two sexes is different in the genus *Drosophila.* The female has seven well-developed dorso-lateral plates, the male only five. The spiracles are correspondingly different—the female has one on the fifth segment and one on the sixth, while the male has two on the fifth. The ventral abdominal plates are also different. The female has six, the male four, and the posterior members of the series are quite different in shape in the two cases.

IX. METHODS OF COLLECTING AND PRESERVING DROSOPHILINAE.

Most of the Drosophilinæ feed on fruit or on fungi, or have leaf-mining larvæ. The most efficient places to collect them are where food is plentiful. Fruit in grocery stores will yield the commoner species, and more especially the widely distributed ones that are presumably introduced. Windfall apples or other decaying fruit usually repays examination. Tomato patches, even before the fruit is ripe, are worth sweeping. Garbage piles usually have many species. Fleshy fungi, either agarics or Boletinæ, will yield many forms; they are more prolific after they have decayed somewhat. Bleeding trees should always be examined.

My own practice has been to expose fruit in the woods, and collect from it daily for a while. The fruit is usually placed in a bottle and hung in a low tree. This method makes it less likely to be stolen by small mammals, and makes collecting easy, as one simply pours the flies into his collecting bottle. After a week or so the bottle may be brought in, and the larvæ and pupæ allowed to develop, thus increasing the collection. For this kind of collecting it is advisable to use many different sorts of fruit. I have found banana, pineapple, tomato, and peach to be specially satisfactory.

I always bring the collections into the laboratory alive, in order to be able to breed any forms that seem desirable. If this is to be done it is necessary to be careful, especially in the case of sweepings, not to leave predacious forms (spiders, empidids, asilids, ants, etc.) or large "messy" ones (grasshoppers, large Hemiptera, etc.) in the same containers. I ordinarily use glass vials for containers, and manipulate the collections between two vials until all undesirables are eliminated. When the collection is in the laboratory it is etherized, and one can examine it carefully at leisure, and dispose of the specimens as he wishes.

If the specimens are to be preserved for taxonomic purposes they should be "pinned"—*not* preserved in alcohol or other fluid. It is not so convenient to examine them in a fluid; and descriptions are made from dried material, so that the size, color, shape, etc., can be more easily compared with descriptions and type specimens if the material is dried. Most entomologists insist that Diptera should always be actually pinned—never gummed on cardboard "points." In practice, however, the small forms, like Drosophilinæ, are usually mounted on points; and the writer personally much prefers this method. It is out of the question to stick a regular insect pin through such small flies, after the fashion adopted for butterflies or other large insects, for the thorax is thereby mutilated beyond recognition. One is usually recommended to use "minuten-nadeln," which are very minute pins, that must be fastened in some way to the regular pin. This method is tedious, and leaves the specimen either insecurely fastened, or else (if the small pins are stuck clear through the thorax) somewhat mutilated. It is also difficult to carry out successfully on a large scale when working with material that has been long dead and dried, for even when relaxed such material is somewhat brittle.

I now mount all my small Diptera on points. Narrow triangular bits of cardboard (ordinary library cards are about the right thickness) are cut, about 8 mm. long and just wide enough at the base to allow an insect pin to be stuck through them. These are mounted, singly, on rather stout insect pins, being placed about a third of the way from the heads of the pins. The specimen is then fastened to the apex of the triangle with a small drop of shellac or glue. The specimen should be mounted on its side, not with the dorsal surface uppermost. This is so that all parts can be examined, at least on one side. The legs are directed toward the pin, so that they are not so likely to be broken off when the specimen is handled later. It is customary to put the pin in the specimen box in such a position that the point projects to the left. The specimen is mounted so that its head will project forward when the pin is so placed, *i. e.*, its left side is fastened to the point.

Each specimen should be labeled with the place and date of capture, and the collector's name may be placed on the same label. Such labels are often obtained in quantity from a printer. In such a case very small type should be used. If a small collection is made from a locality, it is ordinarily more convenient to make small labels by hand, with India ink and a crow-quill pen. Additional data (habits, food on which the specimen was found, etc.) should be placed on a separate label.

It is often not convenient to mount specimens as they are collected. I have found the following method very satisfactory for keeping material until it is mounted: A paper tube is made, by wrapping a small piece of paper around a pencil and bending in one end so it will stay closed. This is then filled with specimens, which are shaken down (before they become thoroughly dry and brittle), until they do not rattle around. Such a tube, with the upper end folded in so as to stay shut, and properly labeled, may be kept indefinitely so long as it is kept free from mold, dermestids, and ants. It will also stand a surprising amount of rough treatment, provided the specimens are not too loosely packed. When one is ready to mount the specimens he has only to place the tube in a moist chamber for a day or two. Then when it is unrolled the specimens will be relaxed and ready for mounting.

A collection of small Diptera is not as difficult to keep up as is a collection of larger insects, for the reason that dermestids do not very often attack such small forms. One must, however, keep such specimens in tight wooden boxes, and moth-balls should be kept in the boxes. If ordinary pins be heated red hot and their heads stuck into moth-balls, the latter may then be readily stuck in the insect boxes. If a collection does become infested, a liberal dose of carbon-bisulphide fumes will remove the difficulty.

A microscope is necessary for the study and identification of most Drosophilinæ. A binocular will be found most convenient. When examining pinned specimens two flat pieces of cork fastened together at a right angle will be found very useful, as they will enable one to examine the specimen from any angle, and yet have it held steady.

Reflected light should ordinarily be used; but for the details of wing-venation transmitted light is sometimes necessary.

X. SYSTEMATIC ACCOUNT.

SYSTEMATIC POSITION OF THE DROSOPHILINE FLIES.

The following represents the classification now current among most students of the Diptera:

Class: Insecta.
Order: Diptera.
Suborder: Cyclorrhapha.
Family: Muscidæ.
Series: Muscidæ acalypteratæ.
Subfamily: Drosophilinæ.

Muscidæ (= **Eumyiidæ, Myodaria, Oligoneura, Muscoidea, etc.**).

Antennæ three-jointed, with an arista on the terminal joint; longitudinal veins never branched; not more than three posterior cells, of which none but the first is ever closed or narrowed at the wing margin; marginal and submarginal cells open; bristles present; empodia never large.

The family is easily split into two main groups, as follows:

1. Calypteræ (Schizometopa). Squamæ large; front of male narrowed or eyes meeting in front; transverse suture of mesonotum complete.
2. Acalypteræ (Holometopa). Squamæ small; front of male rarely narrowed, eyes never meeting in front; transverse suture of mesonotum never complete.

Further subdivision, especially of the Acalypteræ, is very difficult. A number of groups (about 20 to 26 generally recognized) have been segregated as subfamilies, or families if the Muscidæ are treated as a superfamily. The exact definition of these groups is scarcely possible, as in so many cases there are forms that agree with one group in most of their characters, but are aberrant in other respects. Many keys are to be found, but none, I think, will bring all the forms to the groups where they are commonly placed. There are, scattered all through the Acalypteræ, many genera of doubtful affinities. These are put in different subfamilies by each new student. Such forms in the neighborhood of the Drosophilinæ are *Curtonotum*, *Apsinota*, *Aulacigaster*, *Paratissa*, *Stenomicra*, *Periscelis*, *Amphoroneura*, and the forms near *Asteia*. In the present treatment the three first-named have been included in the subfamily, and the others have been excluded. This has been done largely as a matter of convenience. It seems impossible to get a classification into subfamilies that will be generally satisfactory. Certain forms obviously belong close together (*e. g.*, in the present case, *Drosophila*, *Scaptomyza*, *Chymomyza*, *Cladochæta*, *Mycodrosophila*, *Leucophenga*, *Pseudophortica*, *Zaprionus*, *Zygothrica*, *Camilla*, and *Stegana*). Others are more or less like these, and may be included in the group or not, according to the personal equation of the individual student. I have excluded *Paratissa* because it seems to me more like the Ephydrinæ; and *Asteia*, *Crepidohamma*, *Echid-*

nocephala, *Hypselothyrea*, *Liomyza*, *Sigalœssa*, and *Uranucha* because it seems to me that they can conveniently be placed in a group of their own. Specimens of *Periscelis* that I have seen seem to fit best in the Agromyzinæ. The types of *Stenomicra* appear to me to be Geomyzinæ. *Curtonotum* and *Aulacigaster* I have included in the Drosophilinæ because they do not fit well anywhere else, and it is now customary to put them here. It remains very doubtful whether they are really any closer to *Drosophila*, *Stegana*, etc., than are some of the Geomyzinæ (*e. g.*, *Diastata*, *Mumetopia*) or Milichiinæ.

In general, a small acalypterate fly with plumose arista, convergent postverticals, twice-broken costa, rudimentary auxiliary vein, anal cell, and vibrissæ present, is a drosophiline. Any specimen with all these characters may safely be referred here; but every one of these peculiarities is lacking in some member of the group. The postverticals are always convergent if present; but some forms have no postverticals at all. The costa is always at least weakened a second time; but the humeral weakening is in some cases not an actual break. Vibrissæ are present in all North American forms, but absent in the exotic genera *Idiomyia* and *Apsinota*. The anal cell is very often incomplete. The auxiliary vein is well developed in *Curtonotum*, *Apsinota*, and *Aulacigaster*. The arista is pubescent in several genera, pectinate in *Titanochœta*, and has a single branch in *Cladochœta*.

The following subfamilies are the ones most likely to be confused with the Drosophilinæ: Lauxaniinæ, Milichiinæ, Agromyzinæ, Ephydrinæ, Geomyzinæ, Chloropinæ, and Asteinæ. These may usually be distinguished by the following means, though with a little practise one will come to rely fully as much on the general appearance of the specimen, without examining the minute characters, except in rare cases.

Lauxaniinæ: Auxiliary vein distinct throughout its course; two orbital bristles.

Milichiinæ: Arista never plumose; auxiliary vein usually ending in the costa; discal and second basal cells separated; clypeus small; lower orbital bristles convergent.

Agromyzinæ: Costa once broken; postverticals divergent.

Ephydrinæ: Anal cell and anal vein absent; face convex or flat.

Geomyzinæ: Costa once broken; auxiliary vein usually ending in costa; arista seldom plumose.

Chloropinæ: Costa once broken; anal cell and vein absent; vibrissæ absent; arista rarely plumose.

Asteinæ: Anal cell absent; arista usually not plumose; costa not broken at humeral cross-vein.

GENERA OF DROSOPHILINÆ.

The following will serve to characterize the 22 genera here recognized as belonging to the Drosophilinæ. I have examined specimens of 17 of them.

1. Auxiliary vein distinct for most or all of its length.......................... 2
   Auxiliary rudimentary or ending in first vein near its base.................... 4
2. Arista plumose; prescutellars large; mesonotum strongly convex............... 3
   Arista minutely pubescent; no prescutellars or postverticals; mesonotum not strongly convex.. *Aulacigaster*

3. Costa pectinate; vibrissæ large; two large orbitals .... *Curtonotum*
Costa not pectinate; vibrissæ and lower orbital minute or missing .... *Apsinota*
4. Arista minutely pubescent 5
Arista plumose 9
Arista short pectinate; no prescutellars; bristles large .... *Titanochæta*
Arista bare except for one long branch at base; no prescutellars; postverticals small .... *Cladochæta*
5. No ocellar or preapical bristles; one pair of dorsocentrals; prescutellars present. *Acletoxenus*
Ocellars present 6
6. Four pairs of dorsocentrals; a long propleural; two orbitals .... *Blæsochætophora*
One or two pairs of dorsocentrals; three orbitals 7
7. Discal and second basal cells separated; front not unusually hairy ..... *Sinophthalmus*
Discal and second basal cells confluent; front with numerous small hairs 8
8. Carina large; costa weak between third and fourth veins .... *Gitona*
Carina small; costa well developed to apex of fourth vein .... *Pseudiastata*
9. An extra cross-vein between third and fourth veins, near posterior cross-vein... *Idiomyia*
Only anterior cross-vein between third and fourth 10
10. Proboscis longer than height of head; head broader than thorax .... *Zygothrica*
Proboscis shorter than head; head broad only in a few species of *Chymomyza* 11
11. Two pairs of presutural dorsocentrals; distal costal break very deep ..... *Dettopsomyia*
No presutural dorsocentral macrochætæ 12
12. Mesopleuræ bristly; anal cell open at apex; metallic-colored species .... *Camilla*
Mesopleuræ bare 13
13. Discal and second basal cells separated; postverticals small; prescutellars large. *Stegana*
Discal and second basal cells confluent 14
14. Lower reclinate orbital as far from proclinate as from upper reclinate 15
Lower reclinate orbital nearer proclinate than to upper reclinate 17
15. Prescutellars weak or absent; face and carina very prominent .... *Zaprionus*
Prescutellars large; face not protuberant 16
16. Front covered with stout hairs; costa reaches fourth vein .... *Pseudophortica*
Front not unusually hairy; costa weak or absent beyond apex of third vein. *Leucophenga*
17. Lower reclinate orbital large, placed below proclinate; postverticals usually small; eyes bare or nearly so .... *Chymomyza*
Lower reclinate orbital small, placed above proclinate, or, rarely, a trifle below it.. 18
18. One large pair of dorsocentrals; mesonotum and scutellum unusually convex; a single bristle at distal costal break .... *Mycodrosophila*
Not as above; almost always two pairs of large dorsocentrals 19
19. Acrostichal hairs in not more than four rows in front of anterior dorsocentrals, not more than two between the dorsocentrals; slender species with long wings .... *Scaptomyza*
Acrostichal hairs in six or more rows in front (except in *D. opaca*), four or more behind .... *Drosophila*

In the account of each species that I have seen is a section headed "specimens examined." In most cases the name of the collector follows each locality, in parentheses. When one name appears after a State name for which several localities are recorded, then all the records for that State are from that one collector. In some cases the collector is unknown to me, and in these cases the museum in which the specimens are deposited is usually given. In a very few cases even this information is not supplied by my notes. Except for these rare cases, any record without a collector's name is based on my own captures. All records not credited to another collector, from the following localities, are from specimens that I have taken:

Hanover, Nashua, New Hampshire; Monument Beach, Woods Hole, Nantucket, Siasconset, New Bedford, Fall River, Massachusetts; Bear Mount, New York, Staten Island, Cold Spring Harbor, New York; Fort Lee, Paterson, Split Rock Pond, New Jersey; Washington, District of Columbia; Arlington, Richmond, Virginia; Camp Jackson, Greenville, South Carolina; Tampa, Miami, Key West, Florida; Gulfcrest, Kushla, Mobile, Alabama; Havana, San Antonio de los Baños, Santiago de las Vegas, Guareiras, Aguada Pasajeros, Cuba; San Jose, Port Limon, Costa Rica; Panama, Republic of Panama.

Dr. C. W. Metz was with me at Cold Spring Harbor and at all the Cuban localities except San Antonio de los Baños. The specimens collected at these places represent our joint efforts.

The type specimens of all the new species described in this paper are deposited in the American Museum of Natural History. Most of the paratypes and gonotypes are in the author's own collection.

Aulacigaster Macquart. 1835. Suit. Buff., 2, 579.

The European species of this genus was referred to the ephydrine genus *Notiphila* by Fallén, and to the geomyzine genus *Diastata* by Meigen. Schiner placed the genus in the Drosophilidæ, though admitting that it might easily be placed in the Geomyzidæ or Ephydridæ. Williston referred it to the Agromyzidæ, but mentioned it under the Drosophilidæ. Becker, Melander, and Oldenberg all place it among the Drosophilinæ. The genus is aberrant here, but may be left in the subfamily as a matter of convenience, since it does not fit well in any of the other recognized subfamilies.

Arista pubescent; third antennal joint orbicular; two large oral bristles; two orbitals; no ocellars or postverticals; one humeral; no presutural; two notopleurals; mesopleuræ bristly; one sternopleural; two dorsocentrals; two acrostichal rows; one supra-alar; no postalar; no prescutellars; two pairs of scutellars; costa twice broken; auxiliary reaches costa, but is fused with the first vein for a short distance; discal and second basal cells confluent; anal cell and vein present; no evident preapicals. Three chitinized spermathecæ, in which respect the form differs from *Drosophila*, *Scaptomyza*, *Chymomyza*, *Leucophenga*, and *Mycodrosophila*, in all of which only two spermathecæ are present.

There is a single described species, common to Europe and the United States. In Europe it has been recorded from Scotland and Sweden to France, Italy, and Hungary. Williston (1908, Manual N. Amer. Dipt., p. 293) has recorded a species from the West Indies, but this form has never been described, and it is not certainly known whether it represents a second species or not. Our only species is *Aulacigaster leucopeza* Meigen (1830, Syst. Beschr., 6, 100, as *Diastata*) = *Aulacigaster rufitarsis* Macquart (1835, Suit. Buff., 2, 580).

Specimens examined: Hungary (Kertész det.); Italy (Bezzi det.); Hanover, New Hampshire; Woods Hole, Norwood (W. Reiff), Massachusetts; Ithaca, New York (H. Morrison); Pittsburgh, Pennsylvania (H. Kahl); La Fayette, Indiana (J. M. Aldrich); Flat Rock (F. N. Duncan), Carlinville (U. S. Nat. Mus. coll.), Illinois; Marlboro (H. S. Barber), Plummer's Island (W. L. McAtee), Maryland; Washington, District of Columbia (U. S. Nat. Mus. coll.); Dead Run, Virginia (R. C. Shannon); Kushla, Alabama.

Recorded from Kansas (Kahl) and Texas (Loew).

The species is not uncommon about bleeding trees, and I have taken it on a garbage pail.

Curtonotum Macquart. 1843. Dipt. exot., 2, 3, 193.

Diplocentra Loew. 1859. Zeitschr. ent. Breslau. 13, 13.

Like *Aulacigaster* and *Apsinota,* this genus has a well-developed auxiliary vein, so that its position among the Drosophilinæ is somewhat doubtful. The arista is long plumose; two prominent orbitals, placed unusually far from the eyes, with a minute bristle between them; vibrissæ large; ocellars and postverticals large; eyes relatively small, nearly bare; carina small, face slightly convex; front with a few small scattered hairs; two humerals; one presutural; two notopleurals; two supra-alars, anterior one small; two postalars; two dorsocentrals; one prescutellar; two pairs of scutellars, posterior one convergent; disk of scutellum hairy; mesonotum strongly convex; one small propleural; mesopleuræ with a few large bristles (near posterior margin) and numerous hairs; two or three sternopleurals; preapicals on all tibiæ; costa pectinate, weak between tips of third and fourth veins; discal and second basal cells confluent; anal cell and vein well developed; first posterior cell not narrowed at apex; costa twice broken.

Macquart based the genus on a single species, the South American *Musca gibba* Fabricius, which thus becomes the type species. This form had been referred to the genus *Helomyza* by Wiedemann; and Schiner placed the genus in the Helomyzidæ. Loew and Osten Sacken both referred it to the Geomyzidæ, but it is now placed among the Drosophilinæ by common consent (*e. g.*, by Aldrich, Hendel, Melander, Oldenberg, and Williston). It is perhaps most conveniently left here.

There is one Palæarctic species (*C. anus* Meigen), one Oriental (*C. arenata* Osten Sacken, from the Philippines), two Ethiopian (*C. pictipennis* Thomson and *C. fuscipennis* Macquart), one Nearctic (*C. helva* Loew), and twelve Neotropical.

The Neotropical species have been tabled and discussed by Hendel (1913, Deutsch. ent. Zeitschr., 619). *Curtonotum decumanum* Bezzi, from Paraguay, has been described since (1914, Deutsch. ent. Zeitschr., 199). The only ones of these known from our region are *C. gibbum* Fabricius and *C. simplex* Schiner, reported from Mexico by Giglio-Tos. The single Nearctic species is discussed below.

Curtonotum helva Loew. 1862. Berlin ent. Zeit. (as Diplocentra).

Specimens examined: Brattleboro, Vermont (C. W. Johnson); Cohassett (O. Bryant), Chester (C. W. Johnson), Cambridge (C. W. Johnson), Woods Hole (on windfall apples), West Chop (C. W. Johnson), Massachusetts; Buttonwoods, Rhode Island (C. W. Johnson); Orient, Long Island, New York (J. L. Zabriskie); Westville, Riverton, New Jersey (C. W. Johnson); Chesapeake Beach, Maryland (J. M. Aldrich); Virginia Beach, Virginia (F. C. Pratt); Valley of Black Mountains, North Carolina (W. Beutenmuller); Georgia (Morrison); La Fayette, Indiana (J. M. Aldrich); Chicago, Illinois (Aldrich coll.). The type material came from "North Red River."

The breeding-habits of the genus are apparently unknown. Mr. Johnson tells me that *C. helva* is to be collected by sweeping in high grass in moist places, such as are frequented by Sciomyzinæ.

Note. Since the above was written I have seen Enderlein's paper (1917. Zool. Anz. 49; 68–72) dealing with *Curtonotum.* He describes two new species from South America and one from Eritrea (Africa). I am unable to agree with him as to the advisability of separating *Curtonotum* and *Diplocentra*. The character given (number and distribution of sternopleurals) seems too trivial and variable to furnish a natural or convenient generic separation. Even if the separation is accepted, the use of *Diplocentra* as a name is not correct. Since it was proposed as a change of name for *Curtonotum* (because of a supposed preoccupation) it must necessarily have the same type species—and under no circumstances can both names be valid. Enderlein makes his new species *tumidum* the type of *Curtonotum*, on the grounds that it was the form seen by Macquart, who identified it as *Musca gibba* Fabricius. I am unable to agree with the contention that this invalidates *gibba* as the type species.

Enderlein assigns the group to the "Ephydridæ," as a separate subfamily. This treatment has certain points in its favor, and may be accepted or not, according to personal preferences.

Apsinota van der Wulp. 1887. Tijd. v. Ent., 30, 178.

This genus was described by van der Wulp as a geomyzid, and was also referred to that group by de Meijere. Van der Wulp, however, states that the genus is near *Diplocentra* (= *Curtonotum*), and that genus has been referred to the Geomyzinæ by Loew, Osten Sacken, and others. Until data with regard to the costal breaks and other characters are available, it seems best to place *Apsinota* among the Drosophilinæ, next to *Curtonotum*.

Like *Curtonotum*, it differs from typical Drosophilinæ in having a well-developed auxiliary vein. It also agrees with that genus in having a plumose arista, prescutellars present, bristly mesopleuræ, preapicals on all tibiæ, discal and second basal cells confluent, and strongly convex mesonotum. It differs from *Curtonotum* in having small postverticals, large carina, costa not pectinate, only one (reclinate) large orbital, and no large vibrissæ. The last two characters are aberrant in the subfamily.

Two species have been described: *A. pictiventris* van der Wulp, the type of the genus, from Java (van der Wulp and de Meijere) and New Guinea (Kertész), and *A. obscuripes* de Meijere, from Java.

Thaumastophila Hendel (1914, Suppl. ent., 3, 112) differs from *Apsinota* in that the front of the male is very much narrowed. The posterior scutellar bristles are divergent, which is apparently not the case in the described species of *Apsinota*. The only known species is *T. hyalipennis* Hendel, from Formosa. In the key to genera (p. 50) and in the discussion of distribution (p. 115) I have included this form under *Apsinota*. Further study may warrant its separation.

Titanochæta Knab. 1914. Insec. Inscit. Menstr., 2, 168.

This genus suggests the Ephydrinæ in that it has a pectinate arista; flattened, weakly carinate face; head and thorax pruinose. It has, however, well-developed anal cell and vein, and large vibrissæ, so is perhaps most conveniently left here. It also has the following characters: three orbitals, disposed as usual; postverticals long, crossed; ocellars large; eyes hairy; no prescutellars; two notopleurals; two large dorsocentrals; two pairs of scutellars, posterior ones crossed; two sternopleurals; preapicals on all tibiæ, apicals on second; auxiliary vein rudimentary; costa to tip of fourth vein.

The only described species is *Titanochæta ichneumon* Knab, from Hawaii. The specimens were reared from spider eggs. I have examined the types.

Cladochæta Coquillett. 1900. Proc. U. S. Nat. Mus., 22, 263.

Arista with a single long branch above; second orbital minute, a hair between upper orbital and vertex; ocellars present; postverticals small, convergent; one vibrissa; one humeral; one presutural; two notopleurals; two supra-alars; two postalars; two dorsocentrals; two pairs of scutellars; no prescutellars; acrostichal hairs in six rows; one sternopleural; no propleural; apical and preapical bristles on first and second tibiæ, preapicals on third; eyes bare.

The genus is in many respects between *Drosophila* and *Chymomyza*, but differs from both in the reduction of the branches of the arista to one. The small carina, pigmented wings, small postverticals, and bare eyes are all suggestive of *Chymomyza*, but the orbitals are like *Drosophila*. The superficial resemblance to *Drosophila nebulosa* Sturtevant is very striking. Both *Cladochæta nebulosa* and *Drosophila nebulosa* have the habit of waving their wings as do the species of *Chymomyza*.

The type and only species is *Cladochæta nebulosa* Coquillett, 1900 (Proc. U. S. Nat. Mus., 22, 264).

Specimens examined: Arroyo, Bayamon, Mayaguez, Vieques Island, Porto Rico (A. Busck, type series); Herradura (C. W. Metz), Havana, Cristo (C. W. Metz, F. E. Lutz), Guantanamo (C. W. Metz), Cuba; Motzorongo (H. Osborn), San Rafael (Townsend), State of Vera Cruz, Mexico; Lake Worth, Florida (Mrs. Slosson).

Nothing is known as to the breeding-habits of this form, though my observations lead me to suspect that it breeds on fruit. The chromosomes have been described by Metz (see p. 39).

Acletoxenus Frauenfeld. 1868. Verh. zool.-bot. Ges. Wien, 28, 158.

The single species of this genus, *A. formosus* Loew, has sometimes been placed in the genus *Gitona*. Oldenberg (1914, Arch. Naturgesch., 80, A, 4, 28) has presented reasons for separating the genera. The following characters are taken from his account:

Arista pubescent; no ocellars; postverticals small, convergent; front not hairy; three orbitals, disposed as usual; no carina; cheeks very narrow; one dorsocentral; one prescutellar; two well-developed supra-alars; presutural and postalars small; no preapicals; costa well developed to apex of fourth vein.

Acletoxenus formosus Loew occurs in Europe. The larvæ feed on species of *Aleurodes*.

Blæsochætophora Czerny. 1904. Wien. ent. Zt., 206.

Two orbitals; ocellars present; postverticals crossed; vibrissæ present; a pair of prescutellars; one humeral; one presutural; two notopleurals; three "supra-alars"; four dorsocentrals; a long propleural; three sternopleurals; two pairs of scutellars, posterior pair crossed; preapicals only on first tibiæ; arista pubescent; auxiliary vein rudimentary; costa twice broken; anal vein present; third and fourth veins not convergent. Among the forms with pubescent arista and rudimentary auxiliary vein this genus is distinct in that the ocellars and four pairs of dorsocentrals are present, while preapicals occur only on the first tibiæ.

Type and only species: *Leria picticornis* Bigot (1888, Miss. scient. du Cap Horn, 6), from Cape Horn.

Sinophthalmus Coquillett. 1904. Proc. Ent. Soc. Wash., 6, 116.

Arista minutely pubescent; three orbitals, placed high up; postverticals small; vibrissæ present; carina large; front not unusually hairy; no preapicals evident; two dorsocentrals; prescutellars present; two pairs of scutellars; auxiliary vein rudimentary; discal and second basal cells separated; costa reaches fourth vein, not weakened beyond third.

There is a single species, *S. pictus* Coquillett. It is somewhat similar to *Drosophila repleta* in general appearance. It is stated by several collectors to have the habit of getting into one's eyes.

Specimens examined: Mountains near Claremont (C. F. Baker, type), Yosemite (U. S. Nat. Mus. coll.), Mount Lowe (Aldrich coll.), California.

Gitona Meigen. 1830. Syst. Beschr., 6, 129, 215.

Gitonides Knab. 1914. Insec. Inscit. Menstr., 2, 165.

Arista minutely pubescent; three orbitals; front hairy below, but less so above than in *Pseudiastata;* carina present; prescutellars present; preapicals on all tibiæ; vibrissæ present; mesopleuræ bare; auxiliary vein rudimentary; costa reaches fourth vein, but is very weak beyond the third; discal and second basal cells confluent; anal cell and anal vein present.

The genus was based on the European *G. distigma* Meigen. *G. pruinosus* Bigot, from Tunis, is the only other Palæarctic species. The genus *Gitonides*, which does not seem to me to be distinct, includes only the species *G. perspicax* Knab, from Hawaii, the Philippines, and India. The data suggest that it may have been introduced into Hawaii. These three are the only species of the group now known.

G. distigma breeds in the flower-heads of composites, and the larvæ are suspected of being aphidophagous. *G. perspicax* has been bred from larvæ feeding on mealy-bugs (*Pseudococcus*).

I have seen the types of *G. perspicax*, and have examined European material of *G. distigma*, identified by Bezzi and by Kertész.

Pseudiastata Coquillett. 1908. Proc. Ent. Soc. Wash., 9, 148.

Arista minutely pubescent; three orbitals, anterior one convergent, posterior one nearer to verticals than to middle orbital; front covered with small black hairs, as in *Pseudophortica;* vibrissæ large; carina very small; eyes bare; two dorsocentrals; prescutellars present; preapicals on first tibiæ, several bristles near the apices of second and third tibiæ, as in *Pseudophortica;* auxiliary vein rudimentary, but continued as a shadow to costa; costa twice broken, with a large bristle just before the distal break and two such bristles just before the proximal one; costa reaches fourth vein; discal and second basal cells confluent.

There is a single species, *P. nebulosa* Coquillett. It bears considerable superficial resemblance to the genus *Sapromyza*, and it was first described as a geomyzine. Examination shows many points of resemblance to the genus *Pseudophortica*, from which it is easily distinguished by its arista. Only one specimen has been recorded, that was taken at Plummer's Island, Maryland, by H. S. Barber. Mr. Barber tells me that it was taken at night, at a light. I have examined this specimen, and a second one that agrees with it in all essential points, taken at Alajuelo, Panama, by A. Busck.

Idiomyia Grimshaw. 1901. Fauna Haw., 3, 50.

This genus is unique in the possession of an extra cross-vein, between the third and fourth veins, near the posterior cross-vein. It is described as having the following characters: auxiliary vein rudimentary; anal cell present; discal and second basal cells confluent; eyes pubescent; arista plumose; three orbitals, disposed as usual; two pairs of dorsocentrals; two pairs of scutellars, posterior ones crossed; eyes oblique. Mr. Lamb writes me that the vibrissa is absent.

Six species are described in "Fauna Hawaiiensis," all from the Hawaiian Islands. The type is *I. perkinsi* Grimshaw. The species occur on four of the larger islands of the group.

Zygothrica Wiedemann. 1830. Achias Dipt. Genus, 16, 3.

Drosophilura Hendel. 1913. Ent. Mitt., 2, 387.
? *Sphyrnoceps* de Meijere. 1915. Tijds. Ent., 58, suppl.; 58.

Arista plumose; two or three orbitals; vibrissæ present; ocellars present; postverticals large; face protuberant; carina large; head broader than thorax; antenna inserted opposite middle of eye; proboscis longer than height of head; no prescutellars; preapicals evident on second and third tibiæ; discal and second basal cells confluent; costa twice broken, reaches apex of fourth vein.

The type species is *Achias dispar* Wiedemann, described from Brazil and since recorded from Peru, Bolivia, and Panama. *Z. aldrichii* Sturtevant, from Panama, is the only other American species. *Sphyrnoceps brunneus* de Meijere, from the East Indies, probably also belongs here. I have discussed the synonymy of these forms elsewhere (Sturtevant, 1920, Proc. U. S. Nat. Mus. 58, 155).

The curious produced eyes of some of the males of *Z. dispar* caused Wiedemann to describe the species as a diopsine. They do not occur in the female of this species, or in either sex of the other species. Similar eyes are to be found in some undescribed Neotropical species of *Chymomyza*, close to *C. procnemis*. The present group is not close to *Chymomyza* in other respects.

The two American species have both been bred from fungi.

Dettopsomyia Lamb. 1914. Trans. Linn. Soc. London, 16, 349.

Arista plumose; two orbitals, upper reclinate, lower proclinate; postverticals crossed; vibrissæ and ocellars present; eyes pilose; carina large and broad; two dorsocentrals, plus two small presutural ones; acrostichal hairs in two rows; two humerals; one presutural; two pairs of scutellars, posterior ones crossed; two sternopleurals; costa reaches apex of fourth vein, twice broken, distal break deep, milichiid-like; costal index a little less than 1.0.

There is a single described species, *D. formosa* Lamb, from the Seychelles.

Camilla Haliday. 1838. Ann. Nat. Hist., 2, 188.

Arista plumose; orbitals disposed as usual, middle one minute; postverticals medium size, convergent; vibrissæ present; two notopleurals; mesopleuræ bristly; two dorsocentrals; no prescutellars; many acrostichal rows of hairs; presuturals long; two pairs of scutellars; costa twice broken; anal vein absent; anal cell open at apex; auxiliary vein rudimentary; no preapicals on third tibiæ.

The type species is the European *C. glabra* Fallén. Seven species are described, as follows:

Palæarctic: *C. glabra* Fallén, Europe, Canary Islands; *C. acutipennis* Loew, Europe.
Ethiopian: *C. africana* Bezzi, Kongo.
Oriental: *C. cæruleifrons* de Meijere, Java; *C. javana* de Meijere, Java; *C. pusilla* de Meijere, Java; *C. rugulosa* de Meijere, Java.

I have examined both European species.

Stegana Meigen. 1830. Syst. Beschr., 6, 79.

Phortica Schiner. 1862. Wien. ent. Monatsschr., 6, 433.
Amiota Loew. 1862. Berlin. ent. Zeit., 6.
Eostegana Hendel. 1913. Deutsch. ent. Zeit., 390.
Orthostegana Hendel. 1913. Deutsch. ent. Zeit.

Arista plumose; three large orbitals, placed high up, uppermost one nearer to verticals than to lowest (proclinate) orbital; postverticals small; eyes nearly bare; vibrissæ and ocellars present; one humeral; one presutural; two dorsocentrals; prescutellars present; two scutellar pairs; mesopleuræ bare; preapicals on all tibiæ; discal and second basal cells separated; costa reaches fourth vein; anal cell and anal vein present.

I have ventured to unite the two long-recognized genera *Stegana* and *Phortica*. They are usually (*e. g.*, by Schiner, by Williston, and by Oldenberg) stated to differ in that *Stegana* has wings bent down at the base and has the third and fourth veins strongly convergent, while in *Phortica* the wings are straight and the third and fourth veins are parallel or nearly so. But these two characters are not always associated. Hendel has described two new genera: *Eostegana*, with bent-down wings but first posterior cell not narrowed; *Orthostegana*, with wings straight but first posterior cell narrowed. The narrowing of the first posterior cell is a character that shows variations from species to species, so that it is hard to know where to draw the line between "narrowed" and "not narrowed." The bending down of the wings is still more elusive, at least in pinned material. I am convinced, from an examination of many specimens, including the types, that *Phortica vittata* Coquillett is based on specimens of typical *Stegana* in which the wings are straight. I have seen specimens in which one wing was straight, the other bent down. Specimens of *Phortica humeralis* Loew sometimes have the wings bent down. These two genera are perhaps distinct; in general appearance and in the shape of the head two types certainly exist, but the wing characters that have been used as the only means of separating them are evidently not valid.

The type species of *Stegana* is *S. coleoptrata* Scopoli, a European species, designated as type by Westwood (1840, Intr., 2, 153). The type of *Phortica* is the European *Drosophila variegata* Fallén, which was the only species included in the genus originally.

The group here considered as forming the genus *Stegana* includes nine described Palæarctic species (Europe), five Neotropical (St. Vincent, Peru, Bolivia; I have seen the genus from Mexico and Central America), and twelve Oriental (Ceylon to Formosa and New Guinea). I have seen an Ethiopian specimen, collected by the American Museum Kongo Expedition. Our knowledge of the Nearctic species is in a very unsatisfactory condition, and I am not sure that the treatment given below will stand after more study. Six Nearctic species are recorded, but I am unable to recognize more than two in the large number of specimens that I have seen.

Stegana coleoptrata Scopoli. 1763. Ent. Carniol., 338 (Musca).

S. hypoleuca Meigen. 1830. Syst. Beschr., 6 (♂).
Phortica vittata Coquillett. 1901. Proc. U. S. Nat. Mus., 23.

Loew recognized *S. curvipennis* Fallén (as *S. nigra* Meigen) from North America; I have seen a specimen so labeled in the Loew collection, from Pennsylvania. I am unable to see any good reason for separating this specimen from *S. coleoptrata,* though it appears from the accounts of Schiner and of Oldenberg that in Europe the two species are quite distinct. The European species seem to have been little understood in Loew's time. It is now customary to identify the darker specimens as *S. coleoptrata,* the lighter ones as *P. vittata;* but intermediates occur; and I can find no other character that will separate the supposed two species.

Specimens examined: Mount Desert, Maine (C. W. Johnson); Mount Washington (Mrs. Slosson), Franconia (Mrs. Slosson), Bretton Woods (C. W. Johnson), New Hampshire; Brattleboro, Vermont (C. W. Johnson); Brookline, Fall River, Massachusetts (C. W. Johnson); Buttonwoods, Rhode Island (C. W. Johnson); Danbury, Winnipauk, Middletown, Rowayton, Darien, Connecticut (C. W. Johnson); South Wales (M. C. VanDuzee), Ithaca (S. W. Frost), New York; Delaware Water Gap (type of *vittata*), Clemonton (C. W. Johnson), Avalon (C. W. Johnson), New Jersey; Polk County, Wisconsin (C. F. Baker); Great Falls, Virginia (N. Banks); Daytona, Florida (C. W. Johnson).

Recorded in Europe from England to Hungary.

Stegana humeralis Loew. 1862. Centuria, 2, 93 (Amiota).

A. leucostoma Loew. 1862. Centuria, 2, 94.
(?) *Drosophila alboguttata* Wahlberg. 1838. K. Vet. Ak. Hand., 22.

The types of Loew's two species are quite distinct in color. *S. humeralis* is somewhat shining black in general color, while *S. leucostoma* is brown. I can find no other differences, and an extensive series of more recent material shows graded color variations completely connecting these two extremes. Wahlberg's species was recognized from the Nearctic by Loew. Two specimens so labeled in the Loew collection (from New Hampshire and New York, respectively), appear to me to belong to the same species as the type of *S. humeralis.* I am, however, unwilling to substitute Wahlberg's name without more study.

Specimens examined: Waubamic, Parry Sound, Ontario (Aldrich coll.); Franconia (Mrs. Slosson), Center Harbor (H. G. Dyar), Glen House (C. W.

Johnson), New Hampshire; St. Johnsbury, Mount Ascutney, Burlington, Vermont (C. W. Johnson); Newton, North Adams, Riverside, Auburndale, Brookline, Chester, Bashbish Falls, Massachusetts (C. W. Johnson); Apponaug, Rhode Island (C. W. Johnson); Plattsburg (H. G. Dyar), Niagara Falls (C. W. Johnson), Staten Island, (F. Schrader), New York; Westville, Delaware Water Gap, Dover, Newark, Riverton, New Jersey (C. W. Johnson); type locality of *humeralis* (Loew coll.), Philadelphia (C. W. Johnson), North Mountain (C. W. Johnson), Pennsylvania; Plummer's Island, Maryland (J. R. Malloch); District of Columbia (type of *leucostoma*); Scotts Run (H. S. Barber), Great Falls (Nathan Banks), Dead Run (R. C. Shannon), Virginia; La Fayette, Indiana (J. M. Aldrich); Chiric Mountains, Arizona (H. G. Hubbard).

The species of this group have apparently not been bred. They are to be found in woods, and are stated to be attracted by perspiration and to hover near the eyes of people.

Zaprionus Coquillett. 1902. Proc. U. S. Nat. Mus., 24, 31.

Arista plumose; three orbitals, lower (proclinate) placed well below the other two (reclinate); postverticals large, convergent; ocellars present; vibrissæ present; eyes densely pubescent; face and carina prominent; one presutural; two notopleurals; two supra-alars; two postalars; two dorsocentrals; prescutellars very small or absent; two pairs of scutellars; disk of scutellum bare; two sternopleurals; preapicals on second tibiæ; costa twice broken; auxiliary vein rudimentary; discal and second basal cells confluent; anal cell and anal vein present. The tubercles on the under side of the front femora stated by Coquillett to be present in the male of the type species occur in the female of that species also, but are absent in the other two species that I have seen.

The type species is *Z. vittiger* Coquillett. It is recorded in the Ethiopian region from Rhodesia (Coquillett); Kamerun (Kahl); Senegal, Eritrea (Bezzi); Seychelles (Lamb). I have seen specimens from Liberia (R. P. Currie). *Drosophila orbitalis* Sturtevant, from Panama, belongs in this genus. I have seen, in the United States National Museum, specimens of an apparently undescribed species collected in India (Compere) and in Java (Bryant and Palmer).

The type specimens of *Z. vittiger*, collected by C. P. Lounsbury, are labeled "prickly pear." This is the only hint as to the habits of the genus that I have found.

Pseudophortica Sturtevant. 1918. Journ. N. Y. Ent. Soc., 26, 37.

Arista plumose; three large orbitals, upper two reclinate, lower proclinate and situated above middle of front; postverticals small, widely separated, convergent; front covered with black hairs except at vertex; face with well-developed carina; one large vibrissa; eyes nearly bare; two dorsocentrals; one prescutellar; acrostichal hairs in more than ten irregular rows; one humeral; one presutural; two notopleurals; two supra-alars; two postalars; two pairs of scutellars, posterior ones crossed; one small propleural; two sternopleurals; mesopleuræ bare; several apical bristles on each tibia, those on the second pair larger; a few short, stout apical bristles on each of the four basal tarsal joints of the second and third pairs of legs; costa twice broken, reaches apex of fourth vein, but is very weak beyond the third; auxiliary vein rudimentary, but a shadow continues to the distal costal break; discal and second basal cells united; third and fourth veins slightly divergent at tips; wing tip rounded.

The type and only recorded species is *Pseudophortica obesa* Loew (1872, Berlin ent. Zeit., 16, as *Drosophila*) = *Phortica hirtifrons* Johnson (1913, Bull. Amer. Mus. Nat. Hist., 32, 88).

Specimens examined: Ocean View, Virginia (A. N. Caudell); Coal Creek, Tennessee (W. S. Adkins); Southern Georgia (Morrison: this specimen is headless); Lakeland (C. W. Metz), Crescent City (M. C. Van Duzee, type of *hirtifrons*), Florida; Kushla, Alabama (on persimmons); Texas (type material of *obesa*).

Leucophenga Mik. 1886. Wien. ent. Zeit., 317.
Oxyleucophenga Hendel. 1913. Ent. Mitt., 2.
Drosomyiella Hendel. 1914. Suppl. ent., 3, 113.
Paraleucophenga Hendel. 1914. Suppl. ent., 3, 114.
Paraleucophenga Oldenberg. 1914. Arch. Naturgesch., 80 A, 4, 18.
Neoleucophenga Oldenberg. 1914. Arch. Naturgesch., 80 A, 9, 93.

Arista plumose; three large orbitals, uppermost nearer to inner vertical than to lowermost orbital; postverticals small; face not markedly carinate; vibrissæ present; prescutellars present; two dorsocentrals; one humeral; two notopleurals; two supra-alars; two postalars; two scutellar pairs, posterior ones crossed; no propleural; auxiliary vein rudimentary; discal and second basal cells confluent; costa very weak or absent beyond apex of third vein; preapicals on second and third tibiæ.

The type species is the European _Drosophila maculata_ Dufour. This species, like the two nearctic ones, breeds in fungi. This habit, while usual, is not invariable in the group, as I have bred _L. varia_ Walker from tomatoes.

The five synonyms given above all represent attempts to split the genus into smaller groups, but all seem to me to be based on too slight differences to warrant new generic names. The supposed generic characters and the type species follow:

Oxyleucophenga Hendel: Wings distinctly pointed. Type, _O. undulata_ Hendel, from Peru.

Drosomyiella Hendel: Second orbital unusually large, third orbitals slightly convergent. Type, _Drosophila abbreviata_ de Meijere, from Java and Formosa.

Paraleucophenga Hendel: Arista pectinate. Type, _P. triseta_ Hendel, from Formosa.

Neoleucophenga Oldenberg (new name for _Paraleucophenga_ Oldenberg, not Hendel): Costa reaches apex of fourth vein. Type, _Leucophenga quinquemaculata_ Strobl, from Europe.

The following 45 species may be referred to the genus _Leucophenga_. Those marked with an asterisk (*) are here referred to this genus for the first time, so far as I know. All these except the types of _Oxyleucophenga_ and _Paraleucophenga_ Hendel were originally described as species of _Drosophila_. All have been referred to _Leucophenga_ on the basis of the published descriptions, except _obscuripennis_ Loew. I have examined the type specimen of the latter species. The unstarred species described by de Meijere and by Lamb were referred to _Leucophenga_ not as a genus but as a subgenus of _Drosophila_.

Nearctic, 2: _maculosa_ Coquillett, Eastern United States; _varia_ Walker, Eastern United States.

Neotropical, 10: _argenteiventris_ Kahl, Bolivia; _argenteo-fasciata_ Kahl, Brazil; _bimaculata_ Loew, Cuba; _brunneipennis_ Kahl, Bolivia; _frontalis_ Williston, West Indies, Honduras; _hasemani_ Kahl, Brazil; _maculosa_ Coquillett, Florida, West Indies, Peru; *_obscuripennis_ Loew, Cuba; _ornativentris_ Kahl, Bolivia (Paraguay?); *_undulata_ Hendel, Peru.

Palæarctic, 3: _leucostoma_ Becker, Europe; _maculata_ Dufour, Europe; _quinquemaculata_ Strobl, Europe.

Ethiopian, 11: _ambigua_ Kahl, Kamerun; *_apicifera_ Adams, Rhodesia; *_basilaris_ Adams, Rhodesia; *_flaviseta_ Adams, Rhodesia; _goodi_ Kahl, Kamerun; _grossipalpis_ Lamb, Seychelles; *_mansura_ Adams, Rhodesia; *_mutabilis_ Adams, Rhodesia; *_palpalis_ Adams, Rhodesia; *_proxima_ Adams, Rhodesia; _sericea_ Lamb, Seychelles.

Oriental, 20: *_abbreviata_ de Meijere, Java, Formosa; _albiceps_ de Meijere, Java; *_albicincta_ de Meijere, Java; _argentata_ de Meijere, Java; _bellula_ Bergroth, Queensland; _bistriata_ Kahl, Philippines; _cincta_ de Meijere, Java; _gibbosa_ de Meijere, Java; _guttiventris_ de Meijere, Java; _insulana_ Schiner, Nicobar Islands; _invicta_ Walker, Borneo, Java; _limbipennis_ de Meijere, Java; _nigriventris_ Macquart, Cochin China; _ornatipennis_ de Meijere, Java; *_quadripunctata_ de Meijere, Java; _salatigæ_ de Meijere, Java; _stelliplenis_ Walker, New Guinea; _subpollinosa_ de Meijere, Java; _tectifrons_ de Meijere, Java; *_triseta_ Hendel, Formosa.

Deducting for the double entry of *maculosa*, the total is 45 species.

The genus may be divided into two groups on the basis of the palpi. In one group they are slender and clavate, in the other they are broad and flat. Each group is described from four of the main geographical regions. The group with flat palpi is not to be recognized from the descriptions of Palæarctic species, nor that with clavate palpi among those described from the Oriental region. I have, however, seen specimens from Australia and from Java that have clavate palpi.

The five North American forms may be separated as follows:

1. Palpi clavate, yellow 2
   Palpi broad and flat 3
2. Tip of first vein dark, wings otherwise clear .... *frontalis*
   Dark spots at tips of first and second veins .... *varia*
3. Palpi yellow; both cross-veins and tips of first and second (sometimes also third) veins clouded .... *maculosa*
   Palpi black 4
4. Large black spots at tips of first and second veins; posterior cross-vein and tip of third clear .... *bimaculata*
   Spot on second vein also extends along third to wing tip; that at tip of first reaches to base of anal cell; posterior cross-vein surrounded by a black spot.. *obscuripennis*

For a detailed discussion of certain species of the genus, and a more extensive key, see Kahl's paper (1917, Ann. Carnegie Mus., 11, 364).

Leucophenga varia Walker. 1849. List. Ins. 4 (as Drosophila).

Drosophila quadrimaculata Walker. 1856. Dipt. Saund., 4.

Specimens examined: Woods Hole, Massachusetts; Riverton, New Jersey (C. W. Johnson); Philadelphia, Pennsylvania (C. W. Johnson); Plummer's Island, Maryland (R. C. Shannon); Brookland, District of Columbia (R. C. Shannon); Bloomington, Indiana (F. Payne); Illinois River (Melander collection); La Follette, Coal Creek, Tennessee (W. S. Adkins); valley of Black Mountains, North Carolina (W. Beutenmuller); southern Georgia (Morrison); Jacksonville, Florida (Amer. Mus. Nat. Hist. coll.); Kushla, Alabama; Opelousas, Louisiana (Melander collection). Also recorded from New York, West Virginia, and Kansas by Kahl.

Leucophenga maculosa Coquillett. 1895. Proc. Acad. Nat. Sci. Phila., 47 (as Drosophila).

Specimens examined: Flatbush (J. L. Zabriskie), New York, New York; Plummer's Island, Maryland (R. C. Shannon); Rock Creek, District of Columbia (R. C. Shannon); Bloomington, Indiana (F. Payne), North Carolina (U. S. Nat. Mus. coll.); Archer (type material), Biscayne Bay (Mrs. Slosson), Florida; Kushla, Alabama; Victoria, Texas (E. A. Schwarz); Herradura, Cristo, Cuba (C. W. Metz); Sanchez, Haiti (F. E. Watson); Lima, Peru (Parrish). Recorded from Pennsylvania, Illinois, and Kansas by Kahl. I suspect that *L. hasemani* Kahl, from Brazil, is a synonym. My specimens of *maculosa* from Alabama and Cuba have the apex of the third vein infuscated as in *hasemani*, though they agree with Kahl's description of *maculosa* in the position of the orbitals. These two characters were the basis of the separation into two species made by Kahl.

Leucophenga frontalis Williston. 1896. Trans. Ent. Soc. Lond. (as Drosophila).

Specimens examined: Mayaguez, Porto Rico (F. E. Lutz); Guantanamo (F. E. Lutz), Havana, near Pinar del Rio (F. E. Lutz), Cuba; La Ceiba, Honduras (F. J. Dyer). Described from St. Vincent, West Indies.

Leucophenga bimaculata Loew. 1865. Berlin. ent. Zeit., 9 (as Drosophila).

Specimens examined: type material (Gundlach), Herradura (C. W. Metz), Cristo (C. W. Metz), Cuba.

Leucophenga ornatipennis Loew. 1865. Berlin. ent. Zeit., 9, 183 (as Drosophila).

Specimens examined: type material (Gundlach), Bartle (C. W. Metz), Cuba. The specimen from Bartle has more yellow on the abdomen than the type, but apparently represents the same species.

Chymomyza Czerny. 1903. Zeit. Hymenopt. Dipt., 3, 3, 199.

Arista plumose; lower reclinate orbital large, placed below proclinate orbital; ocellars present; postverticals small; vibrissæ present, other oral bristles large; eyes bare or nearly so; carina confined to upper part of face; a few enlarged ommatidia in lower front part of eye; two dorsocentrals; two scutellar pairs, posterior ones crossed; a small propleural sometimes present; preapicals on all tibiæ; first femora of males with numerous strong bristles below; costa reaches fourth vein; anal cell and vein present; hypopygium prominent; slender species.

The species are to be found around bleeding trees, on windows, or at fruit. Dr. Metz and I have bred *C. procnemis* Williston from banana, and *C. amœna* Loew from apple and banana. Shannon has bred the latter from walnut and butternut husks, and Banks has bred it from acorns. The members of the genus have a characteristic habit of waving their wings constantly, after the fashion of species of *Sepsis* or *Euxesta*.

The type species is *Drosophila fuscimana* Zetterstedt, from Europe. The following species may be recognized:

Palæarctic: *Chymomyza albopunctata* Becker; *C. caudatula* Oldenberg; *C. costata* Zetterstedt; *C. distincta* Egger; *C. fuscimana* Zetterstedt.
Ethiopian: *C. bicolor* Lamb.
Nearctic: *C. aldrichii* Sturtevant; *C. amœna* Loew; *C. caudatula* Oldenberg; *C. procnemis* Williston.
Neotropical: *C. procnemis* Williston.

Deducting for double entry of *caudatula* and *procnemis*, the total is nine species.

Oldenberg (1914, Arch. Naturgesch., 80, A, 2, 14) has discussed the Palæarctic species. He has studied the male genitalia, which are evidently of importance as taxonomic characters in this group. I have found their study difficult to carry out, however, and have used the character only enough to identify *C. caudatula* from the Pacific coast, and to determine that *C. procnemis* (specimens from Lakeland, Florida) is distinct from *C. fuscimana* and *C. distincta*, which it greatly resembles. I am certain that a study of these organs would show that what passes as *C. procnemis* is really a mixture of several species.

There are at least two Neotropical species of the genus *Chymomyza* (Haiti, British Guiana) with laterally produced eyes, suggestive of *Zygothrica*. I have not described them because it seems better to wait for a study of the male genitalia before attempting to determine specific limits in the section of the genus to which they belong.

The described North American species may be separated by the following key:

1. Wings much spotted; front legs yellow .... *amœna*
   Wings clear, or blackish along anterior margin, or with a white tip; front femora, tibiæ, and basal tarsal joints blackish 2
2. Front yellow or reddish yellow .... *procnemis*
   Front dark opaque brown 3
3. Wings clear; face whitish .... *caudatula*
   Costal cell brown; face brown .... *aldrichii*

Chymomyza amœna Loew. 1862. Berl. ent. Zeit., 6, 230 (as Drosophila).

Specimens examined: Hanover, New Hampshire (C. W. Johnson); Brattleboro, Vermont (C. W. Johnson); Worcester (C. W. Johnson), Chester (C. W. Johnson), Monument Beach, Woods Hole, Fall River, New Bedford, Massachusetts; Kingston, Rhode Island (C. W. Johnson); Hartford (Mrs. Slosson), New Haven (C. W. Johnson), Rowayton (C. W. Johnson), Connecticut; Ithaca (S. W. Frost), Cold Spring Harbor, New York, New York; Fort Lee, Paterson, New Brunswick, New Jersey; Plummer's Island, Maryland (R. C. Shannon); District of Columbia (type material); Dead Run (R. C. Shannon), West Falls Church (N. Banks), Virginia; Black Mountains, North Carolina (W. Beutenmuller); Greenville, South Carolina; Bloomington, Indiana (F. Payne); Algonquin (D. W. Coquillett), Chicago (W. M. Wheeler), Illinois; near St. Louis, Missouri; Kushla, Alabama; Palestine, Austin (W. M. Wheeler), Texas. Recorded from Pennsylvania (Kahl); Michigan, Kansas (Aldrich); Georgia, Louisiana (Melander).

Chymomyza procnemis Williston. 1896. Trans. Ent. Soc. London, 412 (as Drosophila).

Specimens examined: Franconia, New Hampshire (Mrs. Slosson); New York, New York; Algonquin, Illinois (D. W. Coquillett); Dead Run, Virginia (R. C. Shannon); Biscayne Bay (Mrs. Slosson), Atlantic Beach (Mrs. Slosson), Tampa (C. W. Metz), Lakeland (C. W. Metz), Florida; Kushla, Mobile, Alabama; Herradura (C. W. Metz), Aguada Pasajeros, Cuba; Montserrat, Trinidad, West Indies (A. Busck); Panama, Republic of Panama (A. Busck). Described from St. Vincent by Williston; recorded from Pennsylvania, Kansas, and Brazil by Kahl.

Chymomyza caudatula Oldenberg. 1914. Arch. Naturgesch. 80, A, 2, 14.

Specimens examined: Pullman, Mount Constitution, Washington (A. L. Melander). Described from Hungary.

Chymomyza aldrichii Sturtevant. 1916. Ann. Ent. Soc. Am., 9, 325.

Specimens examined: Potlatch, Yale, Idaho (J. M. Aldrich).

Mycodrosophila Oldenberg. 1914. Arch. Naturgesch., 80, A, 2, 4.

This genus was based on the species *Amiota* (*Phortica*) *pœcilogastra* Loew (= *Drosophila johni* Pokorny), from southeastern Europe. The group was recognized by Lamb (1912, Trans. Linn. Soc. London, 16) and. suggested as a subgenus of *Drosophila*, though no name was given to it. Lamb described three species, from the Seychelles, that he placed in this group: *Drosophila fracticosta*, *D. nigerrima*, and *D. nigrobrunnea*. He also pointed out that *D. gratiosa* de Meijere, from Java, belongs in the same group. I have referred all four of these species to *Mycodrosophila* (1918, Bull. Amer. Mus. Nat. Hist., 38, 442). A little earlier (1918, Journ. N. Y. Ent. Soc., 26, 38) I had referred *Drosophila dimidiata* Loew (Eastern States) and *D. projectans* Sturtevant and *D. thoracis* Williston (both from the West Indies), to the same genus. To this list we may now add *Drosophila pleuralis* Williston, also from the West Indies. We have, then, nine species; one Palæarctic, one Nearctic, three Neotropical, three Ethiopian, one Oriental.

The genus is characterised as follows: middle (lower reclinate) orbital minute; postverticals large, convergent; thoracic bristles as in *Drosophila*, except that the anterior dorsocentral pair is missing or extremely minute, and prescutellars are never present; preapical bristles on first and second tibiæ indistinct or missing; eyes bare or nearly so; mesonotum "humped up"; scutellum rounded, not so flat as in *Drosophila;* distal costal incision (just before tip of first vein) deep, costa somewhat swollen just basal to the incision; a single bristle before the distal costal break, instead of the usual two. The nine species are all dark and shining above, pale yellow on pleuræ, legs, and face; abdomen shining dark brown or black with pale yellow markings.

M. pœcilogastra, *M. dimidiata*, *M. thoracis*, and *M. gratiosa* are all frequenters of fungi, in which at least the last three breed.

The four American species may be distinguished by the following key:

1. Costal index little over 1.0; a black band from apex of costal cell to apex of anal cell .... *M. projectans*
   Costal index at least 1.3; no band at base of wings 2
2. Scutellum velvety .... *M. dimidiata*
   Scutellum shining 3
3. Abdomen mostly black, yellow marks only on fifth segment .... *M. pleuralis*
   Abdomen black and yellow on each segment .... *M. thoracis*

Mycodrosophila dimidiata Loew. 1862. Berl. ent. Zt., 6 (as Drosophila).

Specimens examined: Franconia, New Hampshire (Mrs. Slosson); Woods Hole, Massachusetts; Alpine, Riverton (C. W. Johnson), Fort Lee, New Jersey; Pittsburgh, Pennsylvania (H. Kahl); District of Columbia; Plummer's Island, Maryland (R. C. Shannon); North Carolina; Bloomington, Indiana (F. Payne); Flat Rock (F. N. Duncan), type locality (Loew material), Illinois; Georgia; Kushla, Alabama.

M. pleuralis Williston. 1896. Trans. Ent. Soc. London, p. 411 (as Drosophila).

Not seen. Described from St. Vincent, West Indies.

M. thoracis Williston. 1896. Trans. Ent. Soc. London, p. 411 (as Drosophila).

Specimens examined: Isle of Pines (bred from fungi, C. W. Metz). Described from St. Vincent, West Indies.

M. projectans Sturtevant. 1916. Ann. Ent. Soc. Amer., 9, 342 (as Drosophila).

Specimens examined: San Francisco Mountains, Haiti (A. Busck); Montserrat, Trinidad, West Indies (A. Busck).

Scaptomyza Hardy. 1849. Proc. Berwickshire Nat. Club, 349.

Very close to *Drosophila*, but differs in the following respects: two or four acrostichal rows of hairs in front of the transverse suture (six or more in *Drosophila*), two rows between the dorsocentral bristles (four or more in *Drosophila*); occiput more convex than in *Drosophila;* thorax, abdomen, and wings more slender; prescutellars never present.

The larvæ are usually leaf-miners, but this is not invariably the case. I have bred both *S. adusta* Loew and *S. graminum* Fallén on tomato fruit, on potato tubers, and on banana agar, though these species are both ordinarily leaf-miners. Malloch has bred *S. adusta* from mulberry sap.

This genus was based on the two European species *Drosophila graminum* Fallén and *D. flaveola* Meigen. *D. graminum* was designated as the type by Coquillett (1910, Proc. U. S. Nat. Mus., 37, 603). The following species may be taken as valid members of the group:

Palæarctic: *Scaptomyza amœna* Meigen; *S. flava* Fallén; *S. flaveola* Meigen; *S. gracilis* Walker; *S. graminum* Fallén; *S. griseola* Zetterstedt; *S. incana* Meigen; *S. rufipes* Meigen; *S. tetrasticha* Becker; *S. unipunctum* Zetterstedt (Czerny. 1903, Wien. ent. Zeit., 22).

Nearctic: *S. adusta* Loew; *S. graminum* Fallén; *S. terminalis* Loew.

Neotropical: *S. vittata* Coquillett.

Oriental: *S. bimaculata* de Meijere; *S. substrigosa* de Meijere.

These may be summarized thus:

Palæarctic	10
Nearctic	3
Neotropical	1
Oriental	2
Total	16
Less 1, for double entry of *graminum*	15

The Palæarctic forms have been tabled and discussed by Becker (1908, Mitt. zool. Mus., 4). The four North American forms may be separated by the following key:

1. Four acrostichal rows in front of the suture; usually with a dark spot at tip of third vein	2
Two acrostichal rows; wings unspotted	3
2. Two large humerals	*terminalis*
One large humeral	*adusta*
3. Dark brownish, pollinose on mesonotum; palpi yellow	*graminum*
Yellowish, not pollinose; palpi dark	*vittata*

Scaptomyza terminalis Loew. 1863. Berl. ent. Zeit., 7, 32 (as Drosophila).

Drosophila apicata Thomson. 1868. Eugen. Resa., 597.

Specimens examined: Sitka, Alaska (Loew's type); Mount Constitution, Vashon, Winlock, Washington (A. L. Melander); Moscow Mountain, Idaho (A. L. Melander); Claremont, San Mateo County (Baker), Muir Woods (J. C. Bradley), Eureka (H. S. Barber), Palo Alto (J. M. Aldrich), California; Kaslo, British Columbia (R. P. Currie); Vancouver; Mount Washington, New Hampshire (Mrs. Slosson); Eastport, Maine; Montreal, Quebec (Melander collection); Middletown, New York (C. R. Crosby, "from cabbage"). This species is extremely variable in size, color, and wing-markings. There may be more than one species included. This species is very close to the published descriptions of *S. unipunctum* Zetterstedt, from northern Europe, and may be identical with it.

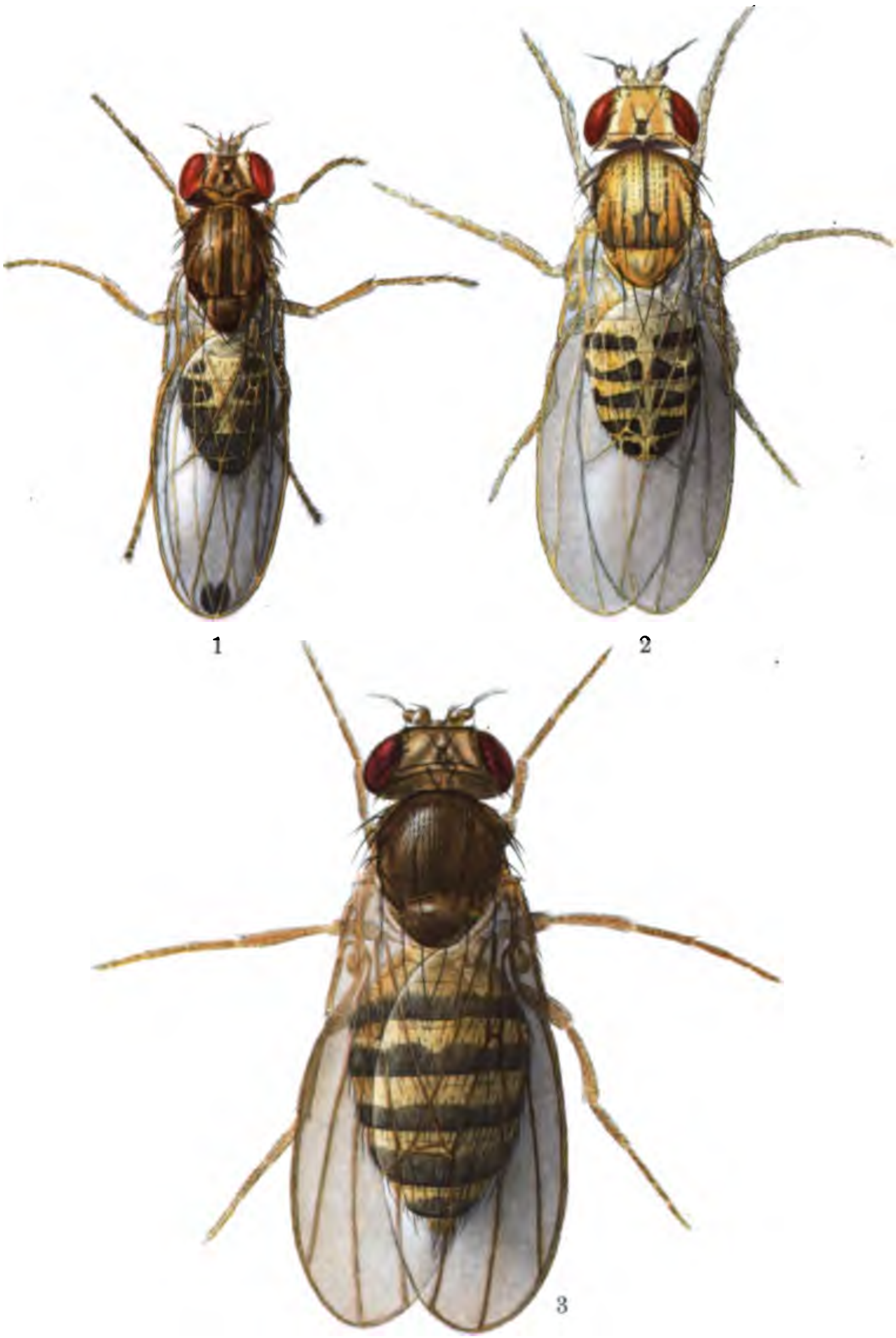
Scaptomyza adusta Loew. 1862. Berlin ent. Zeit., 6, 231 (as Drosophila). (Plate 2, fig. 1.)

Specimens examined: Hanover, New Hampshire; Norwich, Vermont; Monument Beach, Woods Hole, Nantucket, Fall River, New Bedford, Massachusetts; Cold Spring Harbor, New York, Staten Island, New York; New Brunswick, New Jersey; Bloomington, Indiana (F. Payne); Flat Rock (F. N. Duncan), Algonquin (D. W. Coquillett), Illinois; Lawrence, Kansas (E. S. Tucker); Colorado Springs (E. S. Tucker), Boulder (T. D. A. Cockerell), Colorado; Cabin John Bridge, Plummer's Island, Maryland (R. C. Shannon); Washington, District of Columbia; Dead Run (R. C. Shannon), Arlington, Richmond, Virginia; Greenville, South Carolina; Lakeland (C. W. Metz), Tampa (C. W. Metz), Biscayne Bay (Mrs. Slosson), Florida; Gulfcrest, Kushla, Alabama; Opelousas, Louisiana (Melander collection); Austin, Texas (W. M. Wheeler). Recorded from Bermuda by Johnson.

Scaptomyza graminum Fallén. 1823. Dipt. Suec. Geomyz., 8 (as Drosophila).

Drosophila flavipennis Zetterstedt and *D. sordida* Zetterstedt.

Specimens examined: Germany (U. S. Nat. Mus.); Hanover, Isle of Shoals, Mount Washington (Mrs. Slosson), New Hampshire; Norwich, Vermont; Monument Beach, Nantucket, Woods Hole, Fall River, Massachusetts; Cold Spring Harbor, Staten Island, Ithaca (S. W. Frost), New York; Fort Lee, Paterson, New Jersey; Cabin John Bridge, Plummer's Island, Chesapeake Beach, Maryland (R. C. Shannon); Rock Creek, District of Columbia; Dead Run (R. C. Shannon), Great Falls (N. Banks), Arlington, Richmond, Virginia; West Virginia; Bloomington, Indiana (F. Payne); Chicago, Illinois (Melander collection); Clarksville, Tennessee (U. S. Nat. Mus. coll.); Greenville, South Carolina; Kushla, Alabama; Opelousas, Louisiana (Melander collection); Lakeland, Florida (C. W. Metz); College Station, Texas (U. S. Nat. Mus.); Lawrence, Kansas (E. S. Tucker); Potlatch, Idaho (J. M. Aldrich); Almota, Pullman, Washington



E. M. Wallace Pinx.

1, Scaptomyza adusta, ♂.
2, Drosophila busckii, ♂.
3, Drosophila funebris, ♀.

(A. L. Melander); Nelson (A. L. Melander), Kaslo (R. P. Currie), British Columbia. Recorded in Europe from the Faroe, Canary, and Madeira Islands to Sweden, Austria, Egypt, and Corsica.

Scaptomyza vittata Coquillett. 1895. Proc. Acad. Nat. Sci. Phila. 47 (as Drosophila).

Specimens examined: Biscayne Bay, Florida (Mrs. Slosson); Herradura (C. W. Metz), Santiago de las Vegas, Cuba; Yallahas Valley, Jamaica (Amer. Mus. Nat. Hist. coll.); San Jose, Costa Rica. Coquillett recorded the species from Porto Rico. I have seen the specimen in the U. S. National Museum, and am unable to convince myself that it is the same species, though it may well be so.

I have also seen specimens of *Scaptomyza* from Peru and from Argentina. The latter at least were not *S. vittata*. Czerny (1903, Wien. ent. Zeit., 22) has seen the genus from Mexico.

Drosophila Fallén. 1823. Dipt. Suec. Geomyz., 2, 4.

Arista plumose; vibrissæ and ocellars present; three orbitals, lowermost proclinate, upper two reclinate, middle one smaller than the others (second one placed a trifle below the third in *D. alabamensis*); postverticals large (missing in *D. dubia*); one or more humerals; one presutural; two notopleurals; two supra-alars; two postalars; one to three sternopleurals; mesopleuræ bare; two dorsocentrals (one in *D. superba*); prescutellars usually absent (present in *D. sigmoides*, *D. floræ*, and species similar to each, represented by large hairs in *D. repleta* and other forms); two pairs of scutellars, posterior ones crossed; disk of scutellum bare; costa twice broken, reaches apex of fourth vein; two small bristles just before distal costal break (one in *D. immigrans*); discal and second basal cells confluent; anal cell present, often incomplete; preapicals evident at least on third tibiæ; acrostichal hairs in six or more rows in front of transverse suture (four in *D. opaca*), four or more between the anterior dorsocentral bristles.

The name *Drosophila* (Greek; δρόσος, dew, and φίλη, lover) means "dew-lover." This is apparently the reason for the German name "Taufliege." These names are purely fanciful, as the flies are not in any special way dew frequenters. There seems to be no corresponding English term. In English the names fruit fly, pomace fly, sour fly, and vinegar fly are sometimes used. Fruit fly is not a desirable term, as it is commonly restricted to the Trypetinæ, a very different subfamily, many of the larvæ of which feed on growing fruit. Pomace fly and vinegar fly both imply a very much narrower range of normal food habit than actually occurs. The technical name, *Drosophila*, has already become established in biological literature, so that it seems desirable to use it for the common as well as the scientific name.

Many of the best-known genera of Acalypteræ were established by Fallén in his "Diptera Sueciæ"—*e. g.*, *Sciomyza*, *Lonchæa*, *Sapromyza*, *Sepsis*, *Piophila*, *Notiphila*, *Psilopa*, *Ephydra*, *Agromyza*. Among these was *Drosophila*. This genus was described for the following twelve Swedish species, all described as new except one. The present status of those species no longer considered to belong to *Drosophila* is also given.

D. curvipennis Fallén (to *Stegana*).
D. variegata Fallén (to *Phortica* = *Stegana*).
D. funebris Fabricius.
D. fenestrarum Fallén.
D. transversa Fallén.
D. obscura Fallén.
D. tristis Fallén.
D. fuscula Fallén (to *Diastata*—Geomyzinæ).
D. cinerella Fallén.
D. flava Fallén (to *Scaptomyza*).
D. graminum Fallén (to *Scaptomyza*).
D. glabra Fallén (to *Camilla*).

The third of these, *Musca funebris* Fabricius, was designated by Curtis (1833, Brit. Ent., p. 473) as the type species.

Table 8 shows approximately the number of described species that may be taken as probably valid members of the genus. All those described by Walker and by Hutton have been omitted unless recognized later by other students. In general, the opinion of the most recent student has been accepted in matters of synonymy and generic references.

TABLE 8.

	Total species.	Species that also occur in other regions.
Palæarctic	43	7
Ethiopian	22	4
Oriental*	51	4
Nearctic	28	10
Neotropical	41	8
Polynesian	43	3
Total, 228, less 26 duplicate entries, 202.		

* Includes Australia and New Zealand.

This list, of course, is an index of the thoroughness with which the various regions have been studied, as well as of the number of species actually occurring in them. The total of 202 species is certainly far too small. Perkins (Fauna Haw., 1, clxxxix) says not less than 250 species of the tribe must occur in the Hawaiian Islands alone, and most of these forms apparently belong to the genus *Drosophila* itself. All the regions except the Palæarctic and Nearctic will certainly yield very many more species when they are thoroughly collected, and the two regions named are by no means exhausted of new species.

The distribution of the genus within each region is not adequately known, but it seems probable that *Drosophila* is to be found everywhere except in very cold regions. The data on the point that I have collected from the literature and from my own observation of specimens follow:

Palæarctic: Faroe and Canary Islands to Sweden, Egypt, Chinese Turkestan, and Japan.
Ethiopian: Eritrea to Ashantee, Rhodesia, Mauritius, and the Seychelles.
Oriental: New Zealand to the Philippines, Java, and India.
Nearctic: Nova Scotia to British Columbia, southern California, and Florida, Bermuda.
Neotropical: Florida, Bahamas, and Cuba to Argentina, Chile, and Mexico.
Polynesian: Tahiti, Hawaii, Fiji.

D. remota Walker was described from the island of Tristan d'Acunha; but, like most of Walker's species, this can not be accepted until verified.

There are not very many species of *Drosophila* common to the nearctic and Neotropical regions (only eight). In addition, three Neotropical species occur in southern Florida, where Nearctic species are also to be found. Since a number of the Neotropical species are imperfectly known, it is difficult to place them conveniently in a key. Accordingly two keys have been constructed. The first, which is only slightly modified from the one already published (Bull. Amer. Mus. Nat. Hist., 38, 443), includes the known Nearctic species, and the three Neotropical forms found in southern Florida (*D. lutzii*, *D. willistoni*, and *D. cardini*). The second key includes the Neotropical forms known from the West Indies (including Trinidad) and from Central America (including Panama) and Mexico.

NEARCTIC SPECIES OF DROSOPHILA.

1. Acrostichal hairs, just in front of dorsocentral bristles, in six rows 2
Acrostichal hairs in eight rows 20
2. Facial carina very small, absent or very narrow below; second oral bristle not over half length of first 3
Carina broad below 5
3. Yellow; third antennal joint large, with long yellow hairs; fourth-vein index under 2.0 .... *duncani* (p. 86)
Blackish; third antennal joint as usual; fourth-vein index over 2.0 4
4. Costal index 3.0 or over; a comb of stout black bristles on inner side of basitarsal joint of first leg of male .... *affinis* (p. 94)
Costal index under 2.5; no tarsal comb .... *alabamensis* (p. 102)
5. Wings with about thirteen small dark spots along veins; mesonotum yellow, striped with reddish brown; first two to four oral bristles nearly equal. *guttifera* (p. 103)
Wings much clouded; posterior cross-vein sinuate; small prescutellars present. *sigmoides* (p. 70)
Wings clear, or slightly clouded along cross-veins or tips of longitudinal veins... 6
6. A pair of presutural acrostichal bristles present; yellowish-brown species. *putrida* (p. 81)
No presutural acrostichals 7
7. Second orbital about half length of first; only one large oral bristle; yellow species; 2.7 mm. long .... *ordinaria* (p. 86)
Second orbital less than half length of first 8
8. Costal index not more than 2.1; Neotropical species, found in southern Florida... 9
Costal index not less than 2.5 10
9. Reddish-brown species; bristles and branches of arista short; lives in flowers. *lutzii* (p. 74)
Yellow; bristles and arista as usual; lives in fruit .... *willistoni* (p. 89)
10. Ground-color of mesonotum blackish or grayish, not at all yellowish 11
Ground-color of mesonotum yellow, or reddish brown 16
11. Second oral bristle over half length of first; fourth-vein index about 1.8 12
Second oral less than half first 13
12. Carina broad; costal index about 3.0; 2.7 mm. long .... *virilis* (p. 97)
Carina narrow; costal index about 4.0; 1.5 mm. long .... *pseudomelanica* (p. 94)
13. Carina distinctly sulcate; mesonotum grayish pollinose, irregularly marked with reddish brown; 3 mm. long .... *sulcata* (p. 96)
Not as above 14
14. First coxæ black below; 2.5 mm. long .... see *robusta*, below
First coxæ brown; 2 mm. long 15
15. Mesonotum blackish brown; "cheek" one-sixth greatest diameter of eye. *melanica* (p. 95)
Mesonotum brownish black; "cheek" one-third diameter of eye. *melanissima* (p. 95)
16. Wings clear; abdomen banded; only one large oral bristle .... *melanderi* (p. 82)
At least posterior cross-vein slightly clouded 17
17. Reddish yellow; abdomen banded; Neotropical species found in southern Florida. *cardini* (p. 78)
Yellow, not reddish 18
18. Abdomen with interrupted posterior dark band on each of first four segments, and a median anterior spot on third, fourth, and fifth segments. *tripunctata* (p. 82)
Abdomen spotted, but without median spots 19
19. Dull yellow; tips of longitudinal veins not clouded .... *transversa* (p. 81)
Shining yellow; tips of second, third, and fourth veins clouded .... *quinaria* (p. 80)
20. Carina minute; small prescutellars present; wings much clouded .... *inversa* (p. 71)
Carina not minute; prescutellars not clearly differentiated; wings clear or with small clouds along veins 21
21. Mesonotum yellow, with distinct blackish longitudinal stripes; second orbital nearly as long as third .... *busckii* (p. 77)
Mesonotum light gray, with numerous dark-brown spots; carina sulcate 22
Mesonotum not distinctly marked 23

22. First coxa dark brown below; dark abdominal bands with pale spots on lateral margins .... *repleta* (p. 99)
First coxa pale below; pale lateral spots on abdominal segments present. *mulleri* (p. 101)
First coxa pale below; no lateral pale spots on dark abdominal bands... *hydei* (p. 101)
23. Costal index about 1.0; fourth-vein index about 5.5; pleuræ with a dark stripe above .... *quadrata* (p. 76)
Costal index 2.0 or over; fourth-vein index less than 3.0; no pleural stripe 24
24. Blackish species, not at all reddish or yellowish 25
Yellow, or reddish brown 26
25. Costal index about 4.0; 2.5 mm. long; no combs on tarsi .... *robusta* (p. 96)
Costal index about 2.7; 2 mm. long; a comb of short, stout bristles on each of the two basal tarsal joints of the first legs of the male .... *obscura* (p. 93)
26. Costal index less than 3.0; fourth-vein index about 2.3; the male has a comb of short, stout bristles on the basal tarsal joint of the first leg 27
Costal index over 3.5; fourth-vein index less than 1.5; no tarsal combs 28
27. Genital arch of the male with a hook-like posterior process (fig. 13); cheeks relatively narrow (fig. 45) .... *melanogaster* (p. 89)
Genital arch of the male with a clam-shell-like posterior process (fig. 14); cheeks broader (fig. 46) .... *simulans* (p. 91)
28. Dull yellow, not at all reddish; a row of very short, stout bristles on lower apical part of front femur; wings slightly clouded on posterior cross-vein and tips of second and third veins .... *immigrans* (p. 83)
Reddish brown; no combs on femora; wings clear, or occasionally slightly clouded on posterior cross-vein .... *funebris* (p. 84)

NEOTROPICAL SPECIES OF DROSOPHILA.

1. Wings distinctly spotted or clouded other than narrowly along the veins 2
Wings clear, or clouded along veins, or spotted along veins but not on blade 7
2. About ten acrostichal rows; a single pair of dorsocentrals .... *superba* (p. 104)
Six acrostichal rows; two pairs of dorsocentrals 3
3. Prescutellar bristles distinct; bristles brown 4
Prescutellars not differentiated 5
4. Costal index over 3.0; posterior cross-vein sinuate .... *flexa* (p. 71)
Costal index under 3.0 .... *paradoxa* (p. 72)
5. Two large oral bristles; wings entirely smoky; fourth-vein index 2.0 or over. *nebulosa* (p. 88)
First oral over twice second; wings spotted; fourth-vein index under 2.0 6
6. A spot at tip of wing .... *vittatifrons* (p. 103)
Wings spotted also on basal portion .... *calloptera* (p. 103)
See also .... *calloptera ornatipennis* (p. 104)
7. Mesonotum velvety black; four acrostichal rows .... *opaca* (p. 104)
Mesonotum not velvety black 8
8. Face white; six acrostichal rows; carina large; mesonotum yellowish 9
Face not white 10
9. Front yellow; abdomen banded .... *albirostris* (p. 78)
Front brown; abdomen black .... *metzii* (p. 78)
10. Carina absent, or small and confined to upper part of face 11
Carina present below 15
11. Mesonotum yellow in front and on sides, shading into metallic bluish black in middle behind .... *metallica* (p. 73)
Mesonotum more or less definitely striped 12
Mesonotum unmarked, shining black 13
Mesonotum unmarked, yellow or brown 14
12. One prominent oral bristle; third antennal joint long, yellow, hairy... *prognatha* (p. 75)
Two prominent oral bristles; third antennal joint as usual. (*pulchella*—see below, under 22)
13. Scutellum shining black .... *dubia* (p. 73)
Scutellum velvety black .... *splendida* (p. 73)
See also .... *splendida luteipes* (p. 74)

14. Bluish-black metallic stripes on front; costal index 1.5 or less; wings clear. *verticis* (p. 87)
Costa and cross-veins clouded; costal index over 2.0 .... *sororia* (p. 87)
Wings clear; costal index about 1.8 .... *nana* (p. 87)
15. Mesonotum striped or spotted 16
Mesonotum unmarked 29
16. Front not widened above, largely velvety black; palpi dilated, black; face receding; mesonotum dull brown, with two narrow stripes in front... *bilineata* (p. 102)
Not as above 17
17. Acrostichal hairs in six rows 18
Acrostichal hairs in eight rows 23
18. Veins clouded; posterior cross-vein sinuate; prescutellars present. (*flexa*, see above, under 4)
Veins not distinctly clouded; posterior cross-vein straight 19
19. First oral bristle more than twice the second 20
First oral less than twice second 21
20. Mesonotum gray, with dark spots; dull .... *fasciola* (p. 99)
Mesonotum yellow and brown striped; shining .... *poeyi* (p. 76)
21. Fourth-vein index 2.5 or over; 1.5 mm. long .... *saltans* (p. 98)
Fourth-vein index 2.0 or less; usually 2 mm. long 22
22. 4c index 1.0 or less .... (*earlei*—see below, under 28)
4c index over 1.0 .... *pulchella* (p. 88)
23. Mesonotum yellow, with blackish stripes .... *busckii* (p. 77)
Mesonotum blackish or brownish 24
24. Mesonotum gray, with many small dark-brown spots 25
Mesonotum striped or irregularly spotted 27
25. Pteropleura pale yellow; spots between dorsocentral rows largely fused to form two irregular stripes .... *ramsdeni* (p. 102)
Pteropleura brownish in part; numerous spots between dorsocentral rows 26
26. First coxa dark brown below; dark abdominal bands with pale spots on lateral margins .... *repleta* (p. 99)
First coxa pale below; pale lateral spots on abdominal segments present. *mulleri* (p. 101)
First coxa pale below; no lateral spots on dark abdominal bands .... *hydei* (p. 101)
27. Cross-veins slightly clouded; carina subsulcate .... *annularis* (p. 99)
Cross-veins not clouded 28
28. One prominent oral bristle; carina sulcate .... *coffeata* (p. 98)
Two large oral bristles; carina not sulcate .... *earlei* (p. 98)
29. Acrostichal hairs in six rows 30
Acrostichal hairs in eight rows 33
30. First oral bristle over twice second; reddish brown; bristles and branches of arista short .... *lutzii* (p. 74)
First oral bristle not over twice second; yellowish; bristles and branches of arista as usual 31
31. Costal index less than 2.0; fourth-vein index more than 2.0 .... *willistoni* (p. 89)
Costal index more than 2.5; fourth-vein index less than 2.0 32
32. Shining; abdominal black bands broad .... *cardini* (p. 78)
Dull; abdominal black bands narrow .... *similis* (p. 79)
33. Veins distinctly clouded; only one bristle at distal costal break; a row of short, stout bristles on inner distal part of first femur .... *immigrans* (p. 83)
Without any of above characters, except rarely a faint cloud on posterior cross-vein 34
34. Prescutellars present; costal index about 2.5; only one prominent oral bristle... 35
Prescutellars not differentiated 36
35. Yellow species .... *bromeliæ* (p. 72)
Brown species; lives in flowers .... *floræ* (p. 72)
36. One prominent oral bristle; yellow throughout; bristles yellowish ..... *torrei* (p. 86)
Bristles black; black or brown, at least on abdomen 37
37. Mesonotum yellow; costal index under 2.5; fourth-vein index over 2.0 38
Mesonotum brown or black; costal index over 2.5; fourth-vein index under 2.0.. 39

38. Genital arch of male with a hook-like posterior process (fig. 13); cheeks relatively narrow (fig. 45) . . . . *melanogaster* (p. 89)
    Genital arch with a clamshell-like posterior process (fig. 14); cheeks broader (fig. 46) . . . . *simulans* (p. 91)
39. First oral bristle not twice second; not found in flowers . . . . *funebris* (p. 84)
    First oral bristle over twice second; live in flowers 40
40. Brown; costal index over 3.0 . . . . *alfari* (p. 75)
    Black; costal index under 3.0 . . . . *tristani* (p. 75)
    Not included in the above key: *illota* (p. 80).

For purposes of description, the species of *Drosophila* listed below have been separated into several groups. Of these the first three, typified by *D. sigmoides* Loew, *D. floræ* Sturtevant, and *D. dubia* n. sp., respectively, are fairly distinct. They might be separated as new genera if one were inclined to multiply generic names. Perhaps the first two might be united to form a single new genus. The groups typified by *D. lutzii* Sturtevant and by *D. prognatha* Sturtevant, respectively, are also fairly distinct, but are harder to define satisfactorily than are the first three. Among the miscellaneous species, *D. opaca* Williston and *D. superba* Sturtevant are quite unusual, and each of these might serve as the type of a new genus if one were so inclined. *D. calloptera* Schiner and *D. guttifera* Walker are scarcely less anomalous. The other species, I think, may safely be considered as typical congeners of *D. funebris* Fabricius, the type. I have been unable to even make a satisfactory arbitrary division of them into groups.

GROUP A.

Prescutellars present; wings clouded; slender species; bristles and hairs brown; not frequenters of fruit.

Drosophila sigmoides Loew. 1872. Berlin. ent. Zeit., 16, 102.

♂, ♀. Arista with about four branches above and three below. Antennæ yellow, third joint brown. Front over one-third width of head, wider above; brown. Second orbital about one-half other two. Second oral bristle less than half length of first. Carina broad and flat; face yellow. Clypeus prominent. Cheeks yellow; their greatest width about one-sixth greatest diameter of eyes. Eyes with short, fine pile.

Acrostichal hairs in six rows; prescutellar bristles well developed. Mesonotum reddish brown, grayish yellow between the dorsocentral rows. Scutellum grayish yellow. Pleuræ grayish brown. Legs yellow. Apical and preapical bristles on first and second tibiæ; preapicals on third. Bristles and hairs brown.

Abdomen dull brown, no markings visible.

Wings grayish, darker along anterior margin; blackish at tips of second, third, and fourth veins and on both cross-veins. There is usually a clear spot between the second and third veins, and another between the third and fourth. Posterior cross-vein distinctly sinuate. Costal index about 4.0; fourth-vein index about 1.5; 5x index about 1.0; 4c index about 0.7.

Length body 2.3 mm.; wings 2.5 mm.

Specimens examined: Cold Spring Harbor, New York (C. W. Metz); Algonquin, Illinois (D. W. Coquillett); Plummer's Island, Maryland (A. K. Fisher); Falls Church (Nathan Banks), Diggs (R. C. Shannon), Virginia; St. Elmo (near Chattanooga), Tennessee (W. S. Adkins); North Carolina (U. S. Nat. Mus.); Pickett Springs (near Montgomery, F. E. Watson), Gulfcrest, Kushla, Alabama; Plano (E. S. Tucker), type locality (Loew material), Texas.

I have collected this form in southern Alabama by sweeping grass and weeds. Attempts to get it to breed on fruit have not been successful. It was not attracted to fruit that was exposed for several days in a small patch of young plants of *Solidago canadensis*, from which *D. sigmoides* could be swept at any time. The specimen from New York, however, was collected by Dr. Metz on windfall apples.

This species was recorded by Ainslie (1906, Canad. Ent., 38, 44) as bred from the froth of a *Clastoptera*. As I have previously pointed out, the specimens are now in the U. S. National Museum, and are in reality *D. inversa* Walker.

Drosophila flexa Loew. 1865. Berlin. ent. Zeit., 9, 182.

♂, ♀. Arista with four or five branches above and three below. Antennæ yellow. Front over one-third width of head, wider above; dull yellow. Second orbital about one-third other two. Only one prominent oral bristle. Carina low, broad; face yellowish brown. Cheeks yellow; their greatest width about one-sixth greatest diameter of eyes. Eyes with short pile.

Acrostichal hairs in six rows; prescutellar bristles long, not very stout. Mesonotum and scutellum dull yellowish-brown, with three narrow indistinct yellowish stripes: a median one extending from anterior edge of mesonotum to apex of scutellum, and a pair of lateral ones in the dorsocentral lines. Pleuræ brown, yellowish pollinose. Legs yellow. Apical and preapical bristles on first and second tibiæ, preapicals on third. Bristles and hairs brown.

Abdomen dull brown, each segment darker on posterior margin, and more yellowish on lateral part.

Wings with a black spot at tip of each longitudinal vein, that on the second being the largest, and a distinct clouding on each cross-vein. Posterior cross-vein distinctly sinuate. Costal index about 3.7; fourth-vein index about 1.3; 5*x* index about 1.0; 4*c* index about 0.7.

Length body 2.5 mm.; wings 2.7 mm.

Specimens examined: type locality (Gundlach, Loew material), Herradura (C. W. Metz), San Luis (C. W. Metz), near Aguada Pasajeros, Cuba; San Marcos, Nicaragua (Baker); Tabernilla, Panama (A. Busck).

Dr. Metz and I have collected this species in Cuba by sweeping. It has not been found about fruit, and we have been unable to get it to breed on fruit in the laboratory, though the adults are quite hardy.

Drosophila inversa Walker. 1861. Trans. Ent. Soc., 5, 331.

♂, ♀. Arista with three or four short branches above and one or two below. Antennæ brown. Front about one-third width of head, wider above; brown. Second orbital about one-half other two. Only one prominent oral bristle. Carina scarcely present; face pale yellow. Cheeks pale yellow; their greatest width about one-sixth greatest diameter of eyes. Eyes with short pile.

Acrostichal hairs in eight rows; small prescutellars present. Mesonotum and scutellum yellowish brown; pleuræ paler. Legs yellow. Apical and preapical bristles on first and second tibiæ, preapicals on third. All bristles and hairs brown.

Abdomen brown, paler in the dorsal region.

Wings clouded on anterior margin and posterior cross-vein. Posterior cross-vein straight. Costal index about 3.0; fourth-vein index about 1.8; 5*x* index about 2.0; 4*c* index about 0.8.

Length of body 2.5 mm.; wings 2.5 mm.

Specimens examined: Mount Washington, New Hampshire (Mrs. Slosson); Norwich, Vermont (C. W. Johnson); Gloucester, Beverley, Newton, Massachusetts (C. W. Johnson); Ithaca (S. W. Frost), New York, New York; Avalon, Wildwood, New Jersey (C. W. Johnson); La Fayette, Indiana (J. M. Aldrich); Algonquin, Illinois (D. W. Coquillett); Olmsted County, Minnesota (C. N. Ainslie); Bellingham, Washington (A. L. Melander). Walker gives the type locality as "U. S."

The specimens from Minnesota are those reported (as *D. sigmoides* Loew) by Ainslie (1906, Canad. Ent., 38, 44) as bred from pupæ found in *Clastoptera* froth. This is the only available information on the breeding habits of the species. Like *D. nebulosa*, *Cladochæta nebulosa*, and the species of *Chymomyza*, this species has the habit of frequently spreading its wings. All these species have ornamented wings.

NOTE: Since the above was written Baerg (1920, Ent. News, 31: 20) has reported this species as living in the spittle masses of *Clastoptera obtusa*.

Drosophila paradoxa Lamb. 1918. Bull. Ent. Research, 9, 159.

♂, ♀. Arista with four branches above and one below. Antennæ pale yellow. Second and third orbitals inserted at the same level. Only one prominent oral bristle. Carina absent. Palpi pale orange, clavate, with two small bristles near the tip. Eyes with sparse pile.

Acrostichal hairs in six rows; prescutellars well developed. A small dorsocentral bristle in front of the two that are usual for the genus. Mesonotum pale yellow, rather shiny. Scutellum and pleuræ pale yellow. Legs pale yellow. Bristles and hairs brown.

Abdomen yellow, slightly shining; last two segments darker posteriorly.

Wings clouded along anterior margin and posterior cross-vein. Costal index a little over 2; fourth-vein index about 1.6.

Length body just under 2 mm.; wing the same.

I have not seen this species. The above description is drawn entirely from Lamb's admirable account of the type material. The species is known only from St. Joseph, Trinidad, West Indies, where it was collected by Mr. C. B. Williams. It is parasitic on a species of *Clastoptera* found on *Casuarina* trees. Williams collected about thirty spittle masses of this frog-hopper, and "about half of these contained *Drosophila* larvæ, most of which had their heads buried in the abdomen of the *Clastoptera* nymphs, the head being usually inserted between the dorsal abdominal plates."

In the same paper Lamb has presented notes on another Neotropical species of *Drosophila*, found by Williams in the froth of a *Clastoptera* in Panama. The specimens were too fragmentary for description, and the same is true of one that Mr. Williams sent me.

GROUP B.

Small prescutellars present; wings clear; bristles and hairs brown; dull-colored species.

Drosophila floræ Sturtevant. 1916. Ann. Ent. Soc. America, 9, 339.

♂, ♀. Arista with about four branches above and three below. Antennæ dull brown, third joint darker. Front about one-third width of head, wider above; dull yellowish-brown. Second orbital one-half other two. Second oral bristle about one-third first. Carina broad, flat; face dull yellowish-brown. Cheeks yellow; their greatest width about one-eighth greatest diameter of eyes. Eyes with fine black pile.

Acrostichal hairs in eight rows; prescutellars present. Mesonotum, scutellum, and pleuræ dull brown. Legs pale brown; apical and preapical bristles on first and second tibiæ; preapicals on third. Bristles and hairs brown.

Abdomen dark brown; basal segment with a yellowish-brown transverse band.

Wings clear. Costal index about 2.5; fourth-vein index about 1.8; *5x* index about 1.4; *4c* index about 1.0.

Length body 2.2 mm.; wing the same.

Specimens examined: Havana (type series), Guareiras, Cuba; Mayaguez, Adjuntas, Naguabo, Porto Rico (Lutz and Mutchler); Tegucigalpa, Honduras (F. J. Dyer); San Jose, Costa Rica.

The species is to be found, often in great numbers, in the corollæ of large flowers such as those of species of *Datura*, melons, etc. I have reared adults from *Datura* flowers collected in Costa Rica. Some of these took at least eight days to develop—probably longer.

The chromosomes of *D. floræ* have been described by Metz (1916, Amer. Nat., 50, 592; see p. 39 of this paper).

Drosophila bromeliæ, new species.

♀. Arista with about five branches above and two below. Antennæ yellow, third joint darker. Front about one-third width of head, wider above; yellow. Second orbital one-half other two. Second oral bristle less than one-half first. Carina prominent, flat; face pale brown. Cheeks pale brown; their greatest width about one-sixth greatest diameter of eyes. Eyes with fine short pile.

Acrostichal hairs in eight rows; prescutellars present. Mesonotum, scutellum, and pleuræ dull brownish-yellow. Legs pale yellow. Preapical bristles on all tibiæ. All bristles and hairs brown.

Abdomen dull brown, each segment darker posteriorly.

Wings clear. Costal index about 2.5; fourth-vein index about 1.9; 5x index about 1.5; 4c index about 1.2.

Length body 2.2 mm.; wing the same.

Type and two paratypes, Havana, Cuba. January–February, 1915. The male agrees with the above description. The first specimen seen was taken on a pineapple.

The chromosomes have been described by Metz (1916, Amer. Nat., 50, 590; see p. 39 of this paper).

GROUP C.

Postverticals and second orbitals minute; eyes nearly bare; small, metallic-colored species; resemble *Camilla*, but have bare mesopleuræ.

Drosophila dubia, new species.

♂. Arista with about five branches above and two below. Antennæ dark brown. Front over one-third width of head; shining black. Second orbital minute. Only one prominent oral bristle. Carina very small and narrow, confined to upper part of face; face dark brown. Cheeks brown; their greatest width about one-sixth greatest diameter of eyes. Eyes nearly bare. No postverticals evident.

Acrostichal hairs in six rows; no prescutellars. Mesonotum and scutellum shining black. Pleuræ black. Legs brownish yellow, femora brown. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen shining black.

Wings clear. Costal index about 1.8; fourth-vein index about 2.0; 5x index about 1.3; 4c index about 1.3.

Length body 1.5 mm.; wing 1.7 mm.

Type and one paratype, Cristo, Cuba, 1915 (C. W. Metz). Also seen from Herradura (C. W. Metz) and Havana, Cuba; La Ceiba, Honduras (F. J. Dyer). The females agree with the above description.

Drosophila metallica, new species.

♀. Arista with about six long branches above and four below. Antennæ dark brown, prominent. Front about one-half width of head, wider above; dark brown, ocellar dot black. Second orbital very minute. Postverticals minute. Only one oral bristle, that one being rather small. Carina very low, confined to upper part of face; face shining reddish-brown. Clypeus hidden. Cheeks brown; their greatest width about one-sixth greatest diameter of eyes. Eyes nearly bare.

Acrostichal hairs in six rows; no prescutellars. Mesonotum shining reddish-yellow in front and on lateral margins, shading into metallic blue-black in the middle behind. Scutellum velvety black. Pleuræ yellow, with a large dark-brown spot above the middle coxa. Legs yellow. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen shining black.

Wings clear. Costal index about 1.9; fourth-vein index about 2.0; 5x index about 1.8; 4c index about 1.3.

Length body 1.5 mm.; wing 1.7 mm.

Type and one paratype, Bartle, Cuba, 1915 (C. W. Metz).

Drosophila splendida Williston. 1896. Trans. Ent. Soc. London, 412.

"♂, ♀. The large frontal triangle metallic-blue, the sides more brownish and the frontal lunule yellow. Antennæ yellow, the third joint somewhat brownish; arista thickly and long plumose. Face opaque yellow, somewhat blackish in the concavities, with a slight median carina. Mesonotum brilliant deep metallic blue; scutellum deep opaque black; pleuræ black but little shining. Abdomen black, the basal segments more or less yellow, apparently in life with distinct markings. Legs yellow; all the femora more or less black. Wings grayish or yellowish hyaline; third section of the costal vein two-thirds the length of the second section. Anal cell incomplete. Length 2 mm.

"Four specimens. St. Vincent."

I have not seen this species, so have reproduced Williston's description verbatim. There is not enough information in this description to make it certain that the species belongs in the group typified by *D. dubia;* but I have placed it here because of the high probability that the following form, which clearly belongs here, is merely a color variation of Williston's species.

Drosophila splendida luteipes, new variety.

Arista with about six long branches above and three below. Antennæ yellow, brownish above. Front about one-half width of head, wider above; bluish-black above, yellow below. Second orbital exceedingly minute. Postverticals not evident. Only one prominent oral bristle. Carina very small, confined to upper part of face; face pale yellow. Cheeks dark brown; their greatest width about one-sixth greatest diameter of eyes. Eyes nearly bare.

Acrostichal hairs in six rows; no prescutellars. Mesonotum metallic bluish black. Scutellum velvety black. Pleuræ dull brown, yellowish below. Legs, including coxæ, pale yellow. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Four basal segments of abdomen yellow, with posterior black bands. Fifth segment black.

Wings clear. Costal index about 1.4; fourth-vein index about 2.7; 5*x* index about 2.0; 4*c* index about 2.0.

Length body 1.8 mm.; wing 2 mm.

Type and one paratype from Herradura, Cuba, 1915 (C. W. Metz). Also seen from Bartle (C. W. Metz) and Havana, Cuba.

As may be seen from the two descriptions given here, this form agrees closely with Williston's description of *D. splendida*, except in the color of the legs. I have therefore described it as a variety of that species.

GROUP D.

Shining dark species; live in flowers.

Drosophila lutzii Sturtevant. 1916. Ann. Ent. Soc. America, 9, 340.

♂, ♀. Arista with about four short branches above and two below. Antennæ yellowish brown. Front over one-third width of head, wider above; opaque dark brown orbits and triangle polished. Second orbital about one-fourth other two. Only one large oral bristle. Carina rather broad, flat, edges sharply angled; face brown. Cheeks brown, their greatest width about one-fifth greatest diameter of eyes. Eyes with short, sparse pile.

Acrostichal hairs in six rows; no prescutellars. Mesonotum, scutellum, and pleuræ dark reddish-brown, somewhat polished. Legs pale yellowish-brown, femora somewhat darker. Apical and preapical bristles on first and second tibiæ, preapicals on third. All bristles shorter than is usual in the genus.

Abdomen yellowish brown, lighter toward tip.

Wings clear. Costal index about 2.1; fourth-vein index about 1.7; 5*x* index about 1.3; 4*c* index about 1.1.

Length body 1.7 mm.; wing 1.5 mm.

Specimens examined: Biscayne Bay (Mrs. Slosson), Miami, Key West, Florida; Guane (F. E. Lutz), Havana (type material), Guareiras, Aguada Pasajeros, Cristo (F. E. Lutz), Guantanamo (C. W. Metz), Cuba; Hope Gardens, Jamaica (C. W. Metz); Naguabo, Mayaguez, Adjuntas, Porto Rico (Lutz and Mutchler); Mexico City, Mexico (R. Muller); Port Limon, Costa Rica. This species is possibly the same as *D. fusca* Coquillett, from Porto Rico; but the type of that species is lost, and the description does not entirely fit this form, or any other known to me, especially with respect to the orbital bristles.

D. lutzii is very common in many parts of the tropics. It is to be found in large numbers in the flowers of certain plants. I have collected it in

Datura and melon flowers in Cuba, and in morning glories in Costa Rica and Florida. Dr. Metz reports it common in cotton flowers in Jamaica. We have reared adults from the decaying petals of such flowers, and in addition Dr. Metz has bred the species on tomato fruit.

The description of *Drosophila mauiensis* Grimshaw, from Hawaii, suggests that that form is probably similar to this and to *D. tristani.* Its habits are not recorded.

The mating habits of *D. lutzii* are recorded elsewhere in this paper.

Drosophila tristani, new species.

♀. Arista with five short branches above and three below. Antennæ dark brown. Front over one-third width of head, wider above; black. Second orbital about one-sixth other two. Only one prominent oral bristle. Carina very broad and flat; face black. Cheeks dark brown; their greatest width about one-fifth greatest diameter of eyes. Eyes with short pile.

Acrostichal hairs in eight rows; no prescutellar bristles. Mesonotum and scutellum moderately shining black. Pleuræ black. Coxæ and femora dark brown, tibiæ and tarsi pale yellowish-brown. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen shining black.

Wings clear. Costal index about 2.8; fourth-vein index about 1.8; 5*x* index about 1.3; 4*c* index about 0.9.

Length body 1.8 mm.; wing 2.0 mm.

Type, San Jose, Costa Rica, March 1915, in the corolla of an *Ipomea* flower. The species is named for Professor J. F. Tristan, who was acting as my guide when the type and only specimen was collected.

Drosophila alfari, new species.

♂. Arista with about five branches above and two below. Antennæ brown. Front over one-third width of head, wider above; dark brown, lighter below. Second orbital about one-fifth other two. Only one prominent oral bristle. Carina broad and flat; face brown. Cheeks brown; their greatest width about one-fourth greatest diameter of eyes. Eyes with short pile.

Acrostichal hairs in eight rows; no prescutellars. Mesonotum and scutellum dark brown, slightly shining. Pleuræ dull brown. Legs pale yellow. Preapical bristles on all tibiæ, apicals discernible only on second pair.

Two basal segments of abdomen dull brown; third to fifth segments brownish yellow, with posterior interrupted brown cross-bands.

Wings clear, veins yellowish brown. Costal index about 3.6; fourth-vein index about 1.6; 5*x* index about 1.2; 4*c* index about 0.6.

Length body 2.2 mm.; wing 2.3 mm.

Type and 17 paratypes, San Jose, Costa Rica, March 1915, in the corollæ of a large species of *Datura*, in which were also many specimens of *D. floræ*. The species is named for Dr. A. Alfaro, of the National Museum at San Jose.

The females among the paratypes agree with the above description of the male. There are some specimens, of both sexes, in the lot that have some yellow on the two basal segments of the abdomen.

Group E.

Preapicals evident only on third tibiæ; pleuræ or mesonotum striped; carina narrow.

Drosophila prognatha Sturtevant. 1916. Ann. Ent. Soc. America, 9, 340.

♂, ♀. Arista with about six branches above and two below. Antennæ yellow, third joint very long and covered with yellow hairs. Front over one-third width of head; dull yellow, ocellar dot brown. Second orbital one-fourth other two. Vibrissæ long, other oral bristles short. Proboscis prominent and projecting forward. Carina short, low, narrow, and confined to upper part of face; face dull yellow. Cheeks yellow, a brown spot on each side, just above and behind vibrissa. Greatest width of cheeks about one-sixth greatest diameter of eyes. Eyes with yellow pile.

Acrostichal hairs in six rows; no prescutellars. Two large humeral bristles. Mesonotum dull reddish-yellow, with a pair of darker longitudinal stripes and dark areas on and behind the humeri. Scutellum reddish yellow. Pleuræ pale yellow, a reddish line running forward from base of wing; darker above this line. Legs pale yellow. Apical bristles evident only on second tibiæ, preapicals only on third.

Abdomen dull reddish-yellow, with posterior black bands on four basal segments.

Wings clear. Costal index about 1.9; fourth-vein index about 2.0; 5*x* index about 1.8; 4*c* index about 1.4.

Length body 2.0 mm.; wing 2.0 mm.

Specimens examined: Adjuntas, Porto Rico (Lutz and Mutchler, type material); San Francisco Mountains, Haiti (A. Busck).

Some of these specimens are a little smaller and have the dark markings scarcely visible. Since intermediates are present, it seems probable that these differences are due to age.

Drosophila quadrata Sturtevant. 1916. Ann. Ent. Soc. America, 9, 341.

♂, ♀. Arista with about six branches above and three below. Antennæ brown. Front one-half width of head, wider above; pale yellow. Second orbital not larger than neighboring hairs. One large vibrissa, other oral bristles reduced practically to hairs. Carina low and narrow, face broad and excavated on each side of it; face yellow. Proboscis yellow, palpi dark brown. Cheeks yellow; their greatest width about one-fifth greatest diameter of eyes. Eyes with yellow pile.

Acrostichal hairs in eight rows; no prescutellars; the anterior dorsocentrals are only a little behind the transverse suture. Only one large humeral bristle. Mesonotum, scutellum, pleuræ, and legs dull brownish-yellow. There is a dark-brown stripe on the pleura extending as a straight band from just under the haltere almost to the neck. Below this stripe the pleura is paler. Apical bristles evident only on the second tibiæ, preapicals only on third.

Abdomen yellow, each segment with a dark-brown posterior margin.

Wings clear. Costal index about 1.0; fourth-vein index about 5.5; 5*x* index about 6.0; 4*c* index about 5.0.

Length body 1.8 mm.; wing 2.0 mm.

Specimens examined: Kushla, Alabama, April 1915 (type material); Tifton, Georgia, October 1896 (Melander collection); La Fayette, Indiana, July 1915 (J. M. Aldrich).

I collected this species by sweeping, and was unable to get it to breed on fruit.

Drosophila poeyi, new species.

♂. Arista with about five branches above and two below. Antennæ brown, third joint long, darker. Front slightly over one-third width of head; yellow, with two reddish stripes converging below, ocellar dot dark brown. Second orbital about one-half other two. Only one prominent oral bristle. Carina high, narrow; face brownish yellow. Proboscis dark. Cheeks yellow; their greatest width about one-sixth greatest diameter of eyes. Eyes with sparse pile.

Acrostichal hairs in six rows; no prescutellars. Two large humeral bristles. Mesonotum yellow, with six shining reddish-brown stripes, as follows: the broadest pair between the dorsocentral rows, a narrow pair including the dorsocentral rows, and a pair outside the dorsocentral rows reaching only as far forward as the suture. Scutellum shining reddish-brown, with yellow lateral margins. Pleuræ and legs pale yellow. Apical bristles evident only on second tibiæ, preapicals only on third.

Abdomen blackish brown, fourth and fifth segments pale yellow.

Wings clear. Costal index about 2.0; fourth-vein index about 2.0; 5*x* index about 1.7; 4*c* index about 1.2.

Length body 2.0 mm.; wing 2.0 mm.

Type and two paratypes; on window, Poey Museum, National University, Havana, Cuba, January–February 1915.

Drosophila busckii Coquillett. 1901. Ent. News, 12, 18. (Plate II, fig. 2.)

D. rubrostriata Becker. 1908. Mitt. zool. Mus., 4.

D. plurilineata Villeneuve. 1911. Wien. ent. Zeit., 30.

♂, ♀. Arista with about six branches above and two below. Antennæ yellow, third joint dark brown. Front over one-half width of head, wider above; yellow, ocellar dot dark brown. Second orbital nearly as long as third, which is about three-fourths first. Second oral bristle nearly as long as first. Carina high, slightly flattened; face yellow. Cheeks pale yellow; their greatest width about one-third greatest diameter of eyes. Eyes with rather thick pile.

Acrostichal hairs in eight rows; no prescutellar bristles. Mesonotum and scutellum yellow, with three longitudinal black stripes on the mesonotum; one in each dorsocentral line (these do not quite reach the anterior margin of the thorax) and one median one, the latter being bifid behind and the two prongs sometimes joining the lateral stripes at the region of the dorsocentral bristles. There is also a stripe running from just above the humerus to just above the wing. Pleuræ pale yellow, with a reddish-brown stripe running forward from the base of the wing; another one just below the base of the wing; and a spot on the sternopleura. Legs pale yellow. Apical bristles on first and second tibiæ, preapicals evident only on third.

Abdomen yellow, each segment with an apical black band that is interrupted in the mid-dorsal line, and attenuated or interrupted between that line and each lateral margin of the abdomen.

Wings clear. Costal index about 3.1; fourth-vein index about 2.1; *5x* index about 1.9; *4c* index about 1.0.

Length body 2 mm.; wing 2 mm.

Specimens examined: Hanover, New Hampshire; Sharon (C. W. Johnson), Boston (C. W. Johnson), New Bedford, Woods Hole, Massachusetts; New Haven, Connecticut (C. W. Johnson); New York, Flatbush (J. L. Zabriskie), New York; New Brunswick, New Jersey (F. E. Lutz); Plummer's Island, Maryland (R. C. Shannon); District of Columbia (coll. U. S. Nat. Mus.); Clarendon (B. A. Reynolds), Richmond, Virginia; Charlestown, West Virginia (A. Busck, type); Pittsburgh, Pennsylvania (H. Kahl); Elkhart (Johnson coll.), North Manchester (R. R. Hyde), Bloomington (F. Payne), Indiana; Algonquin (D. W. Coquillett), Flat Rock (F. N. Duncan), Illinois; Jacksonville (Mrs. Slosson), Tampa (C. W. Metz), Lakeland (C. W. Metz), Florida; Kushla, Alabama; New Orleans, Louisiana (P. Viosca); Amity, Oregon (D. E. Lancefield); Claremont (L. L. Gardner), Santa Paula (E. O. Essig), California; Santiago de las Vegas, Guantanamo (C. W. Metz), Cuba; Norway (O. L. Mohr); Perth, West Australia (G. Compere). Recorded from Lawrence, Kansas (Kahl); Minnesota (Coquillett); Paris, France, perhaps introduced (Villeneuve); Canary Islands (Becker); Southwest Africa (Schulze).

The synonymy of *rubrostriata* and *plurilineata* has been pointed out both by Becker and by Villeneuve. That both are synonyms of *D. busckii* Coquillett was first pointed out to me by the late Mr. F. Knab, and was published by me (1918, Bull. Amer. Mus. Nat. Hist., 38, 445).

I have bred this species from the following: bread and milk, moist bran, rotten pigeon egg, stale formalinized chicken, sour milk, spinach leaves, banana, flour paste, decayed onions, rotten fish, rotten potato, tomato, fungi. Coquillett records it as bred also from burrows of *Chion cinctus*, and Schulze reared it from a Hottentot's head that had been preserved in formalin. Mr. R. C. Shannon has bred it from butternut husks. Howard records it as caught on human excrement. The surest way of catching it is to expose rotten potatoes or to put out fruit or other suitable material near a stable. It can easily be kept breeding in the laboratory on sour milk or moist bran, and will breed on the banana agar described above.

The eggs have two filaments. The larvæ have curious processes on their surfaces, resembling those of certain Anthomyiinæ. Development requires about two weeks. A flourishing culture of this species will usually smell of ammonia rather than of acetic acid, as in most of the fruit-eating species.

The chromosomes reported by Metz, two mutations reported by Warren, and the mating habits are described elsewhere in this paper.

The larva and pupæ have been described by Johannsen (1910, Bull. Me. Agr. Exper. Sta., 177, 37), and also by Riley (1918, Report State Entomol. Minn., 17). In the latter case the specific determination was not made, but the description and the food-habits are sufficient to identify the species as this one. The pupæ were found in bottles containing certified milk, and were referred to by the farmers as "hay-seeds."

GROUP F.

Typical species. Subgroup 1; yellowish or reddish species.

Drosophila albirostris, new species.

♂. Arista with seven branches above and four below. Antennæ yellow, third joint darker. Front over one-third width of head, wider above; yellow. Second orbital minute. Only one prominent oral bristle. Carina rather broad, flat; face white. Cheeks yellow; their greatest width about one-sixth greatest diameter of eyes. Eyes clothed with fine yellow pile.

Acrostichal hairs in six rows; no prescutellars. Mesonotum and scutellum shining reddish-yellow. Pleuræ and legs pale yellow. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen yellowish red, each segment with a broad black posterior band; these bands are thickened in the mid-dorsal line.

Wings grayish, posterior cross-vein clouded. Costal index about 3.0; fourth-vein index about 1.7; 5x index about 1.0; 4c index about 0.8.

Length body 2.0 mm.; wing 2.2 mm.

Type and only specimen, Panama, Republic of Panama, February–March 1915.

Drosophila metzii, new species.

♂. Arista with seven branches above and three below. Antennæ reddish brown, third joint darker. Front over one-third width of head, wider above; reddish brown, ocellar dot darker. A short transverse impression above base of antennæ. Second orbital minute. Only one prominent oral bristle. Carina very prominent, broad, flat; face white. Cheeks yellowish brown; their greatest width one-sixth greatest diameter of eyes. Eyes with short, fine pile.

Acrostichal hairs in six rows; no prescutellars. Mesonotum and scutellum shining reddish-brown. Pleuræ and legs brownish yellow. Preapicals on all tibiæ, minute apicals on first and second.

Abdomen black, somewhat shining; first segment brown at base.

Wings clear. Costal index about 4.0; fourth-vein index about 1.3; 5x index about 1.0; 4c index about 0.7.

Length body 2.4 mm.; wings 2.5 mm.

Type and only specimen, Herradura, Cuba, February 6, 1915 (C. W. Metz).

Drosophila cardini Sturtevant. 1916. Ann. Ent. Soc. America, 9, 336.

♂, ♀. Arista with about five branches above and two below. Antennæ yellow, third joint brown. Front over one-third width of head, wider above; reddish yellow, orbits grayish. Second orbital about one-fifth other two. Carina broad and flat; face brownish yellow, somewhat polished. Two prominent oral bristles, nearly equal. Cheeks yellow; their greatest width about one-fifth greatest diameter of eyes. Eyes clothed with short pile.

Acrostichal hairs in six rows; no prescutellars. Mesonotum, scutellum, and pleuræ shining reddish-brown. Legs yellow. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen shining black; three basal segments with anterior bands of reddish brown, which do not reach the lateral margin. In some specimens (females) the abdomen is reddish yellow, each segment with a posterior black band.

Wings with small brownish clouds on each cross-vein. Costal index about 3.9; fourth-vein index about 1.7; *5x* index about 1.0; *4c* index about 0.9.

Length body 2.5 mm.; wing 2.5 mm.

Specimens examined: Herradura (C. W. Metz), Havana (type material), Santiago de las Vegas, Aguada Pasajeros, Cristo (C. W. Metz), Cuba; Sanchez, Haiti (F. E. Watson); Mayaguez, Arecibo, Jayuya, Adjuntas, Porto Rico (Lutz and Mutchler); Dominica (F. E. Lutz); San Jose, Port Limon, Costa Rica; Panama, Republic of Panama; Lakeland (C. W. Metz), Tampa (C. W. Metz), Orlando (J. M. Aldrich coll.), Fort Lauderdale (C. W. Metz), Daytona (C. W. Johnson), Miami, Florida.

This species is quite variable in color, but Dr. Metz and I have bred several stocks in the laboratory, and have found these variations not to be inherited, but to depend on the conditions under which the larvæ develop. Pale specimens of the females are very similar to *D. similis* Williston, and I have been unable to devise any satisfactory method of separating them in the case of pinned specimens. The two species are quite distinct, and we have been unable to cross them.

D. cardini is very common about fruit in the tropics. I have bred it from banana and papaya. The development, from egg to adult, requires about two weeks at summer temperature.

The eggs have four filaments. The chromosomes have been described by Metz (1916, Amer. Nat., 50, see p. 39 of this paper). The mating habits are described on page 5.

Drosophila similis Williston. 1896. Trans. Ent. Soc. London, 415. (Not Lamb. 1914. Trans. Linn. Soc. London, 16, 347.)

♂, ♀. Arista with about six branches above and three below. Antennæ yellow, third joint darker. Front over one-third width of head, wider above; yellow. Second orbital one-fourth other two. Second oral bristle about three-fourths first. Carina broad, flat; face yellow. Cheeks yellow; their greatest width about one-fifth greatest diameter of eyes. Eyes pilose.

Acrostichal hairs in six rows; no prescutellars. Mesonotum and scutellum brownish yellow, slightly shining. Pleuræ and legs pale yellow. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen yellow, each segment with a posterior blackish-brown band; the bands on the third, fourth, and fifth segments interrupted in the mid-dorsal region.

Wings slightly clouded on posterior cross-vein. Costal index about 3.2; fourth-vein index about 1.7; *5x* index about 1.2; *4c* index about 0.8.

Length body 2.0 mm.; wing 2.2 mm.

Specimens examined: Herradura (C. W. Metz), Havana, Santiago de las Vegas, Bartle (C. W. Metz), Cristo (C. W. Metz), Cuba; Porus, Port Antonio, Jamaica (C. W. Metz); St. Vincent (Williston type material); Bay Mansion, Barbados (H. A. Ballou). Specimens from Florida, Haiti, Trinidad, Panama, Honduras, and the State of Vera Cruz in Mexico have been examined that possibly belong here; but the lack of any really satisfactory character to separate this species from pale specimens of *D. cardini* Sturtevant makes all these latter determinations doubtful.

Dr. Metz has studied this form in the laboratory, and has reported on its chromosomes (see p. 39), and on a mutation that he obtained in it (see p. 14). He has also seen the egg, which he states has four filaments.

This species is not uncommon about fruit in Cuba. It has been bred on banana through several generations in the laboratory without difficulty.

Drosophila illota Williston. 1896. Trans. Ent. Soc. London, 415.

"♀. Yellowish or brownish-red, the abdomen brown or blackish, the legs yellow. Front as broad or broader than long, a little wider above, opaque brownish or ochraceous yellow, the ocellar tubercle blackish. Third joint of the antennæ twice as broad as long, blackish; arista with two or three rays on the under side. Face more yellowish, in the middle with a strong obtuse carina, leaving a deep depression on each side in which is lodged the antennæ. Palpi and proboscis yellowish. Mesonotum a little shining. Abdomen more reddish toward the base. Wings with a brownish tinge; penultimate section of the fourth vein about one-half as long as the ultimate section; posterior cross-vein nearly as long as the ultimate section of the fifth vein; third section of the costa not half the length of the second section. Length 2¼ mm.

"Two specimens. St. Vincent."

I have not seen this species, so have reproduced Williston's description verbatim. I had suspected that *D. cardini* Sturtevant might be the same, so, through the kindness of Mr. C. G. Lamb, got Mr. E. E. Austen to compare a paratype of *cardini* with the type of *illota*, in the British Museum. He reports that the two species are quite distinct.

Drosophila quinaria Loew. 1865. Berlin. ent. Zeit., 9, 182.

♂, ♀. Arista with about five branches above and three below. Antennæ yellow, third joint darker. Front about one-half width of head, wider above; yellow. Second orbital fine, about one-fourth length of other two. Second oral bristle three-fourths first. Carina broad and flat; face yellow. Cheeks yellow; their greatest width about one-third greatest diameter of eyes. Eyes with short, fine pile.

Acrostichal hairs in six rows; no prescutellars. Mesonotum and scutellum shining reddish-yellow. Pleuræ and legs yellow. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen shining yellow, each segment with four triangular black dots on its posterior margin. In young specimens these spots are brown.

Wings clouded at tips of second, third, and fourth veins and on each cross-vein. Costal index about 2.9; fourth-vein index about 1.5; 5*x* index about 1.1; 4*c* index about 0.9.

Length body 2.2 mm.; wing 2.3 mm.

Specimens examined: Montreal, Canada (C. W. Johnson coll.); Hanover, New Hampshire; Dummerston, Vermont (C. W. Johnson); Auburndale (C. W. Johnson), Chester (C. W. Johnson), Plymouth (C. W. Johnson), Woods Hole, Nantucket, New Bedford, Massachusetts; Buttonwoods, Rhode Island (C. W. Johnson); New Haven, Connecticut (C. W. Johnson); Ithaca (S. W. Frost), Hague (Amer. Mus. Nat. Hist. coll.), Staten Island (F. Schrader), type locality (Osten Sacken), New York; Paterson, New Jersey; Plummer's Island, Maryland (Schwarz and Barber); Falls Church, Virginia (N. Banks); New Galilee (H. Kahl), Philadelphia (C. W. Johnson), Pennsylvania; Medina, Ohio (U. S. Nat. Mus. coll.); La Fayette, Indiana (J. M. Aldrich). It is quite possible that some of these specimens may be really *D. transversa* Fallén, but there can be little doubt that *D. quinaria* covers the range indicated by these records. In addition to these specimens, there are a few that I have identified as being probably *D. quinaria*, but about which I am not certain. If they really represent this species, its range is considerably wider than that indicated above. These specimens are as follows: Moscow Mountain, Idaho (A. L. Melander); Mount Constitution, Washington (A. L. Melander); Eureka, California (H. S. Barber); Beulah, New Mexico (T. D. A. Cockerell); Austin, Texas (W. M. Wheeler).

This species is very similar to *D. transversa* Fallén. Pinned material may usually be distinguished from that species by the clouded tips of the longitudinal veins and the larger and more definite clouds on the cross-veins. The mesonotum is also shinier and more reddish here. Plate 1 and figures 35 and 40.

show that the eggs and spermathecæ are different. The two forms also differ in food habits, since *D. transversa* breeds chiefly on fungi, this species chiefly on fruit. I have bred it from banana, pineapple, tomato, and potato. The species is to be found very commonly about tomato plants, and is not uncommon about windfall apples. It can be bred in the laboratory on banana, but is not easily kept for many generations, and does not breed well in pairs.

The eggs have three filaments, as shown in plate 1. The chromosomes have been described by Metz (1916, Amer. Nat., 50; see p. 39).

Drosophila transversa Fallén. 1823. Dipt. suec. Geomyz., 2, 6.

♂, ♀. Arista with four to six branches above and three below. Antennæ yellow, third joint darker. Front nearly one-half width of head, wider above; dull yellow. Second orbital scarcely one-fourth first. Second oral bristle one-half to three-fourths length of first. Carina broad, flat; face dull yellow. Proboscis and palpi yellow. Cheeks yellow; their greatest width one-sixth to one-fourth greatest diameter of eyes. Eyes with pale pubescence.

Acrostichal hairs in six rows; no prescutellars. Mesonotum and scutellum yellow, slightly shining. Pleuræ and legs yellow. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen yellow, with four posterior black spots on each of the first four segments, and two larger spots on the fifth.

Both cross-veins clouded, wings otherwise clear. Costal index about 3.5; fourth-vein index about 1.8; *5x* index about 1.1; *4c* index about 0.9.

Length body 2 mm.; wing 2.2 mm.

Specimens examined: Hilversum, Holland (J. C. H. de Meijere); Machias, Maine (C. W. Johnson); Hanover, New Hampshire; Boston (C. W. Johnson), Chester (C. W. Johnson), New Bedford (C. W. Johnson), Monument Beach, Woods Hole, Massachusetts; Niagara Falls (C. W. Johnson), Ithaca (S. W. Frost), Staten Island (F. Schrader), Cold Spring Harbor, New York; Fort Lee, Riverton (C. W. Johnson), New Jersey; Bloomington, Indiana (F. Payne); Flat Rock, Illinois (F. N. Duncan); Plummer's Island, Maryland (R. C. Shannon); Dead Run (R. C. Shannon), Falls Church (N. Banks), Virginia; Athens, Tennessee; Kushla, Alabama.

This species breeds on various kinds of fleshy fungi, where it is usually to be found in great numbers, along with *D. putrida* Sturtevant. I have also bred it from potato, but only with difficulty.

It is very similar to *D. quinaria* when pinned, but can usually be distinguished by the characters given in the key. It is possible that some of the records given above really are based on *D. quinaria*, but the range is certainly a very wide one. I am certain of some of the records from Massachusetts, from New Jersey, from Virginia, and from Alabama. The others are not in great doubt; in cases where I could not be reasonably sure of the identification, as between these species, I have omitted the record.

This species is so variable as to suggest that we are really dealing with a complex group. The specimen from Holland, that on this view is most likely Fallén's *D. transversa*, has five branches to the arista above, second oral three-fourths first, and cheeks one-fourth diameter of eyes. Specimens from Monument Beach, Woods Hole, and Ithaca agree well with it.

The eggs have three filaments (see plate 1).

Drosophila putrida Sturtevant. 1916. Ann. Ent. Soc. America, 9, 339.

♂, ♀. Arista with about six branches above and two below. Antennæ yellow brown, third joint dark reddish-brown. Front nearly one-third width of head, wider above; dull yellowish-brown, ocellar dot darker. Second orbital minute. Second oral bristle nearly as long as first. Carina low, rather broad, flat; face yellowish brown, somewhat shiny. Cheeks yellow; their greatest width about one-eighth greatest diameter of eyes. Eyes with fine pale pile.

Acrostichal hairs in six rows; no prescutellars; a pair of presutural bristles in the acrostichal rows next to the outer ones. Mesonotum and scutellum shining brownish yellow. Pleuræ and legs pale yellow. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen pale yellow, each segment with a brown band on posterior margin, interrupted in the mid-dorsal line.

Wings clear. Costal index about 2.8; fourth-vein index about 1.6; 5x index about 1.2; 4c index about 0.8.

Length body 2 mm.; wing 2 mm.

Specimens examined: Princeton (Aldrich coll.), Machias (C. W. Johnson), Maine; Buttonwoods (C. W. Johnson), Hanover, New Hampshire; Brattleboro, Vermont (C. W. Johnson); Chester (C. W. Johnson), Woods Hole (type material), Monument Beach, New Bedford, Massachusetts; Buttonwoods, Rhode Island (C. W. Johnson); New Haven, Connecticut (C. W. Johnson); Niagara Falls (C. W. Johnson), New York, Cold Spring Harbor, New York; Riverton (C. W. Johnson), Ocean County (C. W. Johnson), Fort Lee, New Jersey; Philadelphia (C. W. Johnson), Ohio Pyle (H. Kahl), Pittsburgh (H. Kahl), Pennsylvania; Cheat Mountains, West Virginia (H. Kahl); Plummer's Island (R. C. Shannon), Chain Bridge (R. C. Shannon), Maryland; Brookland, District of Columbia (R. C. Shannon); Dead Run (R. C. Shannon), Falls Church (N. Banks), Richmond, Virginia; Bloomington, Indiana (F. Payne); Flat Rock (F. N. Duncan), Algonquin (D. W. Coquillett), Illinois; Coal Creek, Tennessee (W. S. Adkins); Greenville, South Carolina; Tifton, Georgia (A. L. Melander coll.); Kushla, Alabama; West Point, Mississippi (H. S. Barber). There are specimens from New York in the Loew collection.

The species is very common about fleshy fungi, in which it breeds. I have also reared it from potato, and it can be kept on this food in the laboratory. It is, however, not very satisfactory as a laboratory animal, since it does not breed freely under any conditions that I have been able to supply.

The eggs have four filaments.

Drosophila melanderi Sturtevant. 1916. Ann. Ent. Soc. America, 9, 337.

♀. Arista with about five short branches above and one below. Antennæ yellow, third joint reddish brown. Front nearly one-half width of head; reddish yellow, triangle brown. Second orbital about one-fifth other two. One bristle and numerous hairs on oral margin. Carina low, flat, and narrow; face yellow. Cheeks yellow; their greatest width about one-fourth greatest diameter of eyes. Eyes with fine pale pile.

Acrostichal hairs in six rows; no prescutellars. Two large humeral bristles. Mesonotum and scutellum somewhat shining reddish yellow. Pleuræ reddish yellow. Legs yellow. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen dull yellow, each of first four segments with an interrupted posterior dark-brown band.

Wings clear, veins brown. Costal index about 3.0; fourth-vein index about 1.3; 5x index about 1.1; 4c index about 0.7.

Specimens examined: Tacoma, August 27, 1911 (A. L. Melander, types), Mount Constitution (A. L. Melander), Washington.

Drosophila tripunctata Loew. 1862. Berlin. ent. Zeit., 6, 231.

D. modesta Sturtevant. 1916. Ann. Ent. Soc. Amer., 9, 338.

♂, ♀. Arista with about six branches above and three below. Antennæ pale brown, third joint dark. Front over one-third width of head, wider above; opaque yellow. Second orbital about one-fifth other two. Second oral bristle nearly as long as first. Carina broad, flat; face brownish yellow. Cheeks yellow; their greatest width scarcely equal to one-sixth greatest diameter of eyes. Eyes with yellow pile.

Acrostichal hairs in six rows; no prescutellars. Mesonotum and scutellum dark dull yellowish-brown. Pleuræ and legs pale yellowish-brown. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen shining yellow; an interrupted dark-brown band on the posterior margin of each of the first four segments, and a median anterior dark-brown spot on the third, fourth, and fifth segments.

Wings with faint clouds on each cross-vein and at the tips of second and third veins; veins dark brown. Costal index about 4.3; fourth vein-index about 1.7; *5x* index about 1.3; *4c* index about 0.7.

Length body 2.5 mm.; wing 2.7 mm.

Specimens examined: New Orleans, Louisiana (P. Viosca); Kushla, Alabama (type material of *modesta*); Greenville, South Carolina; Richmond, Arlington, Dead Run (R. C. Shannon), Rosslyn (R. C. Shannon), Virginia; District of Columbia (type material); Plummer's Island, Maryland (R. C. Shannon); Bloomington, Indiana (F. Payne); Urbana, Illinois (J. R. Malloch); Riverton, New Jersey (C. W. Johnson). I have also reared the species from cabbage collected in New York City in November, but I am inclined to suspect that the cabbage was infected somewhere in the south before it was shipped to New York.

I have reared this species in Alabama from banana, watermelon, sap from a bleeding grapevine, and an agaricaceous fungus. It is easily kept in the laboratory on banana.

According to Dr. C. W. Metz, the eggs have four filaments. Dr. Metz has also described the chromosomes (see p. 39).

Drosophila immigrans, new species. (Plate 3, fig. 1.)

D. tripunctata Sturtevant. 1918. Bull. Amer. Mus. Nat. Hist., 38, 445. Not Loew. 1862. Berlin. ent. Zeit., 6, 231.

♂. Arista with about six branches above and three below. Antennæ yellow. Front over one-third width of head, wider above; yellow, ocellar dot dark brown. Second orbital one-fourth size of other two. Second oral bristle over one-half length of first. Carina broad, flat; face yellow. Proboscis yellow. Cheeks yellow; their greatest width about one-third greatest diameter of eyes. Eyes with rather thick pile.

Acrostichal hairs in eight rows; no prescutellars. Mesonotum and scutellum dull brownish-yellow. Pleuræ and legs pale yellow. Apical and preapical bristles on first and second tibiæ, preapicals on third. A row of very short, stout bristles on lower apical part of first femur. Basal joint of first tarsus about half as long as corresponding joint of middle leg, and thicker. Second tarsal joint of first leg also somewhat shortened and thickened.

Abdomen dull yellow, each of the four basal segments with an interrupted posterior black band. The band on the fourth segment is sometimes entire. Fifth segment black.

A single bristle at tip of first costal section (before distal break). Wings clouded at tips of first and second veins and on posterior cross-vein. Costal index about 4.4; fourth-vein index about 1.2; *5x* index about 1.0; *4c* index about 0.5.

Length body 2.5 mm.; wing 2.7 mm.

♀. Same as above, except basal tarsal joint of first leg about two-thirds as long as corresponding joint of second leg, not thicker. Second joint of tarsus of first leg not shortened or thickened.

Type (♂) and gonotypes bred from stock collected at White Plains, New York, 1919. As in the case of *D. hydei*, the gonotypes are not descended from the type, but the whole type series is known to be descended from a single female.

Other specimens examined: Woods Hole, Attleboro (H. H. Plough), New Bedford, Massachusetts; New York, Cold Spring Harbor, Staten Island (F. Schrader), New York; Fort Lee, New Jersey; Springfield, Ohio (W. S. Adkins); Arlington, Maryland (R. R. Hyde); Greenville, South Carolina; Lakeland (C. W. Metz), Daytona (B. B. Horton), Florida; Kushla, Alabama; New Orleans, Louisiana (C. W. Metz); Claremont, California (L. L. Gardner); San Jose, Costa Rica; Norway (O. L. Mohr); Perth, West Australia (G. Compere); Hilo (H. W. Henshaw), Olaa (W. H. Ashmead), Hawaii.

I have previously identified this species as *D. tripunctata* Loew. A reexamination of the type specimen of that species, in the Museum of Comparative Zoology, shows it to belong to the species that I described under the name of *D. modesta*. Becker (1908, Mitt. zool. Mus. Berlin, 4, 155) recorded *D. tripunctata* from the Canary Islands, but stated that the description given by Loew was incomplete. He described the branches of the arista, fourth-vein index, eight acrostichal rows, and dull thoracic color. These notes fit the present species, but not all of them apply to the true *D. tripunctata*. Since *D. immigrans* occurs in Europe, and is in fact almost if not quite cosmopolitan, it seems probable that it is the species that Becker had.

I have bred *D. immigrans* from the following: banana, pineapple, apple, tomato, sour boiled potato, bran mash, graham-flour paste. It is very easily kept in the laboratory on banana agar. It is to be collected about fruit in grocery stores, in tomato patches, and occasionally around fruit exposed in the woods. It is common at Woods Hole and near New York City, but has not appeared in the large series of specimens from Indiana, and is only locally common in the Southern States. I have found only one specimen in Alabama, but it is included in the very small series that I have seen from Daytona and from New Orleans. At San Jose, Costa Rica, I found it very plentiful in the Central Market. The species is curiously rare in collections. I have seen no American specimens collected before 1913. These data, in connection with the fact that the species is common about grocery stores and houses, with the cosmopolitan species, suggest that it is an imported form. It will not be surprising if an earlier name, applied in some other region, is discovered.

The following dates are the earliest ones known to me for this species: 1898 or earlier, Hawaii; 1907, Canaries (?); 1912 or earlier, Australia; 1913, New York, Massachusetts; 1914, Florida, California; 1915, Costa Rica; 1919, Norway.

These data suggest that the species may have come from the Pacific region. It evidently is not one of the forms described from Hawaii by Grimshaw, and since it was probably present in the islands at the time his material was collected, it is possible that it was one of the forms that Perkins believed to be introduced. Such species were apparently usually omitted from the treatments given in the Fauna Hawaiiensis.

The egg of *D. immigrans* has four filaments. The puparium has anterior spiracles that are nearly half as long as the body of the puparium.

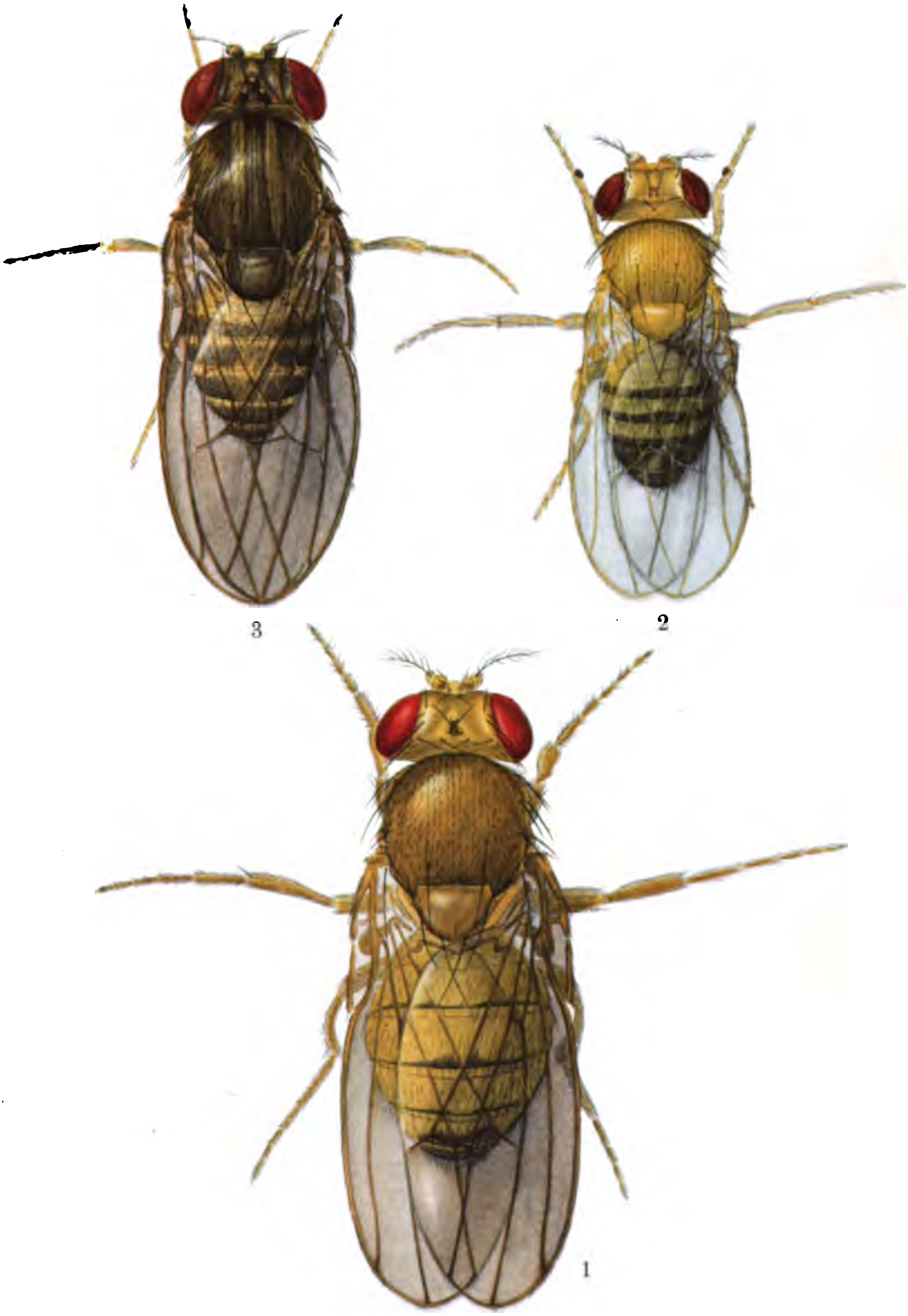
The single costal bristle is suggestive of *Mycodrosophila*, the members of that genus being the only other Drosophilinæ known to me that do not have two such bristles. This form is not to be compared with that genus in any other respect, so this similarity must be supposed to be only accidental.

The chromosomes of *D. immigrans* have been described by Metz (1916, Amer. Nat., 50; see p. 39 of this paper). The mating habits are described elsewhere (p. 6), as are also certain mutations studied by Metz and Metz and by myself (p. 14). The spermatheca is figured on page 36.

Drosophila funebris Fabricius. 1787. Mant. Ins., 2, 345, 33 (as Musca). (Plate 2, fig. 3.)

Musca erythrophthalma Panzer. 1794. Faun. Germ., 17, 24.

♂, ♀. Arista with about six branches above and four below. Antennæ yellow, third joint brown. Front about one-half width of head, wider above; yellowish brown.



E. M. Wallack Pinx.

1, Drosophila immigrans, ♂.
2, Drosophila melanogaster, ♂.
3, Drosophila melanica, ♀.

Second orbital about one-half third, which is about three-fourths first. Second oral bristle over one-half first. Carina broad, flat; face yellowish brown. Cheeks yellow; their greatest width about one-fourth greatest diameter of eyes. Eyes clothed with thick pile.

Acrostichal hairs in six rows; no prescutellars. There are several enlarged hairs in front of the two pairs of dorsocentral bristles and in the same rows with them. Mesonotum and scutellum slightly shining reddish brown. Pleuræ yellowish brown above, becoming yellow below. Legs yellow. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen, in the male, shining black; basal segments with a narrow yellow posterior line, and brownish basally. In the female, the abdomen usually appears largely brown in pinned material. In life it can be seen to be yellowish brown, each segment having a posterior dark-brown band.

Wings clear, veins brown. Costal index about 3.9; fourth-vein index about 1.4; 5x index about 1.1; 4c index about 0.6.

Length body 2.5 mm.; wing 2.5 mm.

Specimens examined: Norway (O. L. Mohr); London, England (E. Brunetti); Holland (J. C. H. de Meijere); Barcelona, Spain (J. Arias); Montreal (U. S. Nat. Mus. coll.), Vaudreuil (coll. C. W. Johnson), Rouville (coll. C. W. Johnson), Quebec; Franconia (Mrs. Slosson), Hanover (C. W. Johnson), Nashua, New Hampshire; Hartland, Vermont (C. W. Johnson); Beverley (Burgess), Boston (C. W. Johnson), Amherst (H. H. Plough), Fall River (C. W. Johnson), Woods Hole, Siasconset, Massachusetts; Kingston, Rhode Island (C. W. Johnson); Meriden, Connecticut (U. S. Nat. Mus. coll.); Niagara Falls (C. W. Johnson), Ithaca (S. W. Frost), Nyack (J. L. Zabriskie, 1884), New York, New York; Riverton (C. W. Johnson), Princeton (S. Mudd), New Jersey; Maryland, near Plummer's Island (R. C. Shannon); Washington, District of Columbia; Virginia, near Plummer's Island (R. C. Shannon); Atlanta, Georgia (U. S. Nat. Mus. coll.); Kushla, Alabama; Columbus, Ohio (F. M. Webster); Bloomington, Indiana (F. Payne); Ann Arbor, Michigan (L. McQuinn); Flat Rock (F. N. Duncan), Algonquin (D. W. Coquillett), Illinois; Madison, Wisconsin (L. J. Cole); Rochester, Minnesota (A. Weinstein); Lawrence, Kansas (E. S. Tucker); Spearfish, Mitchell (A. Huettner), South Dakota; Medicine Hat, Alberta (U. S. Nat. Mus. coll.); Kaslo, British Columbia (R. P. Currie); Moscow, Idaho (A. L. Melander); Pullman, Washington (A. L. Melander); Amity, Oregon (D. E. Lancefield); Los Angeles County, California (U. S. Nat. Mus. coll.); Mesilla, Beulah (T. D. A. Cockerell), New Mexico; Tampico, Mexico (T. E. Holloway); Montserrat, Trinidad, West Indies (A. Busck); Perth, West Australia (G. Compere); Sydney, Australia (A. Musgrave); Rhodesia (U. S. Nat. Mus. coll.).

The species is recorded from Porto Rico by Coquillett, but I have been unable to find the specimens in the National Museum. It is stated by Howard to be recorded from Mauritius. In Europe the species is recorded from Sweden and England to Austria and the Canary Islands.

The eggs and larvæ were described by Unwin (1907, Trans. Ent. Soc. London, p. 285), who also presented data on the habits and on the structure of the adult. The eggs have four rather short filaments, as I have also observed. The chromosomes, investigated by Metz, and the mating habits, are described elsewhere in this paper (pp. 39 and 6, respectively). A brief account of certain mutations that I have obtained will be found on page 14.

This species will breed on fruit of various kinds, and is kept going in the laboratory by means of the technique described for *D. melanogaster* elsewhere in this paper. In nature, however, it is not so frequently to be found about fruit as are many other species. I have found that stables are very favorable places to collect it, and it is almost certain to appear about animal matter that has been preserved in formalin and then allowed to become somewhat stale. It will breed freely in such material. It will breed in fleshy fungi, but is rarely found about them in the woods. It is, in fact, seldom to be found in the woods at all, though quite common about houses, barns, or grocery stores.

Oviposition begins when the females are about three days old, and the adults emerge about two weeks after the eggs are laid, at ordinary moderate summer temperatures. The species is very easily kept in the laboratory, and produces many offspring when kept on banana agar. If it is allowed to breed in a culture for several weeks the agar becomes liquefied, which it does not do in the case of *D. melanogaster*.

Drosophila ordinaria Coquillett. 1904. Proc. Ent. Soc. Wash., 6, 190.

♀. Arista with about six branches above and two below. Head bright yellow, dark-brown ocellar spot. Front over one-third width of head, wider above. Second orbital scarcely one-half other two. Only one prominent oral bristle. Carina flat, not sulcate. Cheeks yellow; their greatest width one-fourth greatest diameter of eyes.

Acrostichal hairs in six rows. Mesonotum, scutellum, pleuræ, and legs yellow. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen yellow, with an interrupted dark-brown posterior band on each segment.

Wings clear. Costal index about 2.7; fourth-vein index about 1.4; *5x* index about 1.2; *4c* index about 0.8.

Length body 2.8 mm.; wing 2.8 mm.

Specimens examined: St. John's County, Quebec (C. W. Johnson coll.); White Mountains, New Hampshire (Morrison, type material); Chester, Massachusetts (C. W. Johnson). The species is recorded from New Jersey in Smith's catalogue, but this is probably an error. All New Jersey specimens so labeled that I have seen are *D. transversa* Fallén or *D. putrida* Sturtevant.

Nothing is known about the habits of this species. I have never seen it alive. The male is unknown.

Drosophila torrei, new species.

♀. Arista short, with four branches above and two below. Antennæ pale yellow. Front about one-third width of head; yellowish brown, ocellar dot dark brown. Second orbital about one-half first. Second oral less than one-half first. Carina narrow; face yellow. Cheeks yellow; their greatest width about one-fifth greatest diameter of eyes. Eyes with fine pile.

Acrostichal hairs in eight rows; no prescutellars. Mesonotum and scutellum dull yellow. Legs and pleuræ pale yellow. All thoracic hairs and bristles are yellowish brown. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen yellow.

Wings clear, veins yellow. Costal index about 2.0; fourth-vein index about 1.4; *5x* index about 1.0; *4c* index about 1.0.

Length body 2 mm.; wing 2 mm.

Type, Havana, Cuba, January–February 1915. This specimen and three gonotypes bred from her (1 male, 2 females) are the only specimens seen. The male agrees with the above description. These specimens were reared on pineapple.

This species is named for Dr. Carlos de la Torre, whose hospitality at the National University in Havana the author was enjoying when the type was collected.

Drosophila duncani Sturtevant. 1918. Bull. Amer. Mus. Nat. Hist., 38, 446.

Arista with about six branches above and two below. Antennæ yellow, third joint darker, long, and clothed with long yellow hairs. Front over one-third width of head, wider above; reddish yellow, orbits and triangle grayish. Second orbital about half the third, which is scarcely over half the first. Carina quite narrow, confined to the upper part of the face. Face and cheeks yellow. Second oral bristle scarcely half the first. Greatest width of cheeks about one-sixth greatest diameter of eyes. Eyes with short, fine pile.

Acrostichal hairs in six rows; no prescutellars. Mesonotum and scutellum dull yellowish-brown. Pleuræ yellow, brownish above. Legs pale yellow. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen yellow, each segment with a dark-brown posterior band that is wider in the mid-dorsal region.

Wings clear. Costal index about 3.8; fourth-vein index about 1.4; 5*x* index about 1.2; 4*c* index about 0.9.

Length of body 2.3 mm.; wing 2.5 mm.

Specimens examined: only the types; Flat Rock, Illinois, 1915 (Dr. F. N. Duncan). Labeled "Fungus."

Drosophila verticis Williston. 1896. Trans. Ent. Soc. London, 413.

"♀. Front very broad above; yellow, the vertical stripes and a stripe or spot near the orbits, metallic-blue; lower part of the front wholly yellowish. Antennæ yellow, the third joint brown; arista with long rays above and below. Face yellow, flat, not carinate. Mesonotum shining reddish-yellow; scutellum opaque brown on its upper surface. Pleuræ more brown. Abdomen apparently yellow, with brown posterior bands to the segments. Legs yellow. Wings nearly hyaline; third section of the costal vein two-thirds or more the length of the second section; anal cell incomplete, the vein closing the cell outwardly indistinct or wanting. Length 2 mm.

"Two specimens. St. Vincent."

I have not seen this species, so have reproduced Williston's description verbatim.

Drosophila nana Williston. 1896. Trans. Ent. Soc. London, 416.

Arista with about five branches above and two or three below. Antennæ yellow, third joint brownish. Front wider above; reddish brown, paler below. Only one conspicuous oral bristle. Carina small, low, confined to upper part of face; face yellowish brown. Palpi brown. Eyes with fine, sparse pile.

Acrostichal hairs in six rows. Mesonotum reddish yellow, shining, pleuræ darker. Legs yellow.

Abdomen black, shining.

Wings clear. Costal index about 1.8; fourth-vein index about 1.8; 5*x* index about 1.2; 4*c* index about 1.6.

Length body 1.8 mm.

The above description was drawn largely from my fragmentary notes on a specimen in the United States National Museum that agrees with Williston's description. A few points not included in those notes have been added from the original description.

Specimen examined: Tabernilla, Canal Zone, Panama (A. Busck). Described from St. Vincent, West Indies.

Drosophila sororia Williston. 1896. Trans. Ent. Soc. London, 412.

Arista with only a few rays. Antennæ yellow. Front over one-third width of head, wider above. Second orbital one-fourth size of other two. Only one prominent oral bristle. Carina represented only by a knob above. Face brown. Cheeks yellow; their greatest width about one-fifth greatest diameter of eyes.

Acrostichal hairs in six rows; no prescutellars. Mesonotum and scutellum dull reddish-yellow. Legs yellow.

Abdomen dark brown, each segment with an indistinct posterior darker band.

Wings clouded along costa and veins, especially on cross-veins and near the wing tips. Costal index about 2.4; fourth-vein index about 2.0; 5*x* index about 1.3; 4*c* index about 1.2.

Length body 1.7 mm.; wing 1.8 mm.

Specimen examined: Montego Bay, Jamaica. This specimen is in the collection of C. W. Johnson, who identified it as *D. sororia*. I am in agreement with Mr. Johnson as to this identification. The specimen lacks the third antennal joints on each side, so the above description is drawn in part from Williston's description, which was based on four specimens from the island of St. Vincent.

Drosophila pulchella Sturtevant. 1916. Ann. Ent. Soc. America, 9, 327.

D. bellula Williston. 1896. Trans. Ent. Soc. London, p. 410 (not Bergroth. 1894. Ent. Zeit. Stettin 55).

♂, ♀. Arista with about five branches above and two below. Antennæ yellow, third joint darker. Front yellowish brown. Second orbital one-fourth other two. Second oral nearly as large as first. Carina short, rather narrow, flat. Face and cheeks yellow.

Acrostichal hairs in six rows; no prescutellars. Mesonotum dark reddish-brown, with three indistinct yellowish stripes. Scutellum brown, with yellow margin. Pleuræ brown. Legs yellowish brown.

Abdomen yellow, each segment with a posterior dark-brown band that is broader in the mid-dorsal region.

Wings clear. Costal index about 2.0; fourth-vein index about 1.9; *5x* index about 1.6; *4c* index about 1.4.

Length body 2.2 mm.; wing 2.3 mm.

Specimens examined: St. Vincent, sea-level (Williston type material); Montserrat, Trinidad, West Indies (A. Busck).

Drosophila nebulosa Sturtevant. 1916. Ann. Ent. Soc. America, 9, 327.

D. limbata Williston. 1896. Trans. Ent. Soc. London, p. 414 (not van Roser. 1840. Württ. Corrbl.).

♂, ♀. Arista with about six long branches above and three below. Antennæ yellow, third joint brownish. Front over one-third width of head, wider above; reddish yellow. Second orbital one-half other two. Second oral three-fourths first. Carina well developed, flat, very slightly indented; face yellow. Cheeks yellow; their greatest width about one-fifth greatest diameter of eyes. Eyes with rather short, thick pile.

Acrostichal hairs in six rows, somewhat irregular; no prescutellars. Mesonotum and scutellum dull yellow. Pleuræ and legs pale yellow. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen yellow, each segment with a broad black posterior band which is thickened in the mid-dorsal line.

Wings smoky, darker along posterior cross-vein and on anterior half. Costal index about 2.4; fourth-vein index about 2.1; *5x* index about 1.6; *4c* index about 1.1.

Length body 2 mm.; wing 2.2 mm.

The species was described by Williston from the island of St. Vincent. I have not seen any of the type material, but have little doubt of the correctness of the determination. The form here described has no combs on the male front tarsi; but there are in the United States National Museum some specimens, bred from Tonka bean pods from Venezuela, in which such combs are present. Otherwise this form agrees fairly well with the description given above. However, to judge from the distribution, there seems little reason to doubt that Williston had the form without sex-combs described above.

Specimens examined: Herradura (C. W. Metz), Havana, Santiago de las Vegas, Cayamas (E. A. Schwarz), Cristo (C. W. Metz), Guantanamo (C. T. Ramsden), Cuba; Sanchez, Haiti (F. E. Watson); Manati, San Juan, Porto Rico (Lutz and Mutchler); Bay Mansion, Barbados (H. A. Ballou); Panama, Republic of Panama. Described from St. Vincent.

This species is common about fruit in Cuba. It breeds freely in the laboratory on slightly fermented banana, and has been reared from pineapple and from guava. About twelve days are required for its development from egg to adult. The eggs have two filaments.

The chromosomes have been described by Metz (1916, Amer. Nat., 50; see p. 39 of this paper). The mating habits are described elsewhere in this paper (see p. 6).

Drosophila willistoni Sturtevant. 1916. Ann. Ent. Soc. America, 9, 327.

D. pallida Williston. 1896. Trans. Ent. Soc. London, p. 415 (not Zetterstedt. 1847. Dipt. Scand., 6).

♂, ♀. Arista with about six branches above and three below. Antennæ yellow. Front over one-third width of head, wider above; yellow. Second orbital about one-third other two. Second oral bristle nearly as long as first. Carina flat, not nose-like; face yellow. Cheeks yellow; their greatest width about one-eighth greatest diameter of eyes. Eyes distinctly pilose.

Acrostichal hairs in six rows; no prescutellars. Mesonotum and scutellum yellow, slightly shining. Pleuræ and legs pale yellow. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen yellow, each segment with a dark-brown posterior margin.

Wings clear. Costal index about 1.8; fourth-vein index about 2.1; *5x* index about 1.8; *4c* index about 1.4.

Length body 1.8 mm.; wing 1.8 mm.

Specimens examined: Miami, Florida; Nassau, Bahamas (A. Busck); Herradura (C. W. Metz), Havana, Santiago de las Vegas, Guantanamo (C. W. Metz, C. T. Ramsden), Cuba; Haiti (coll. A. L. Melander); Porus, Jamaica (C. W. Metz); Bayamon (A. Busck), Mayaguez (Hooker), Porto Rico; St. Vincent (Williston type material); San Jose, Port Limon, Costa Rica; Panama, Republic of Panama; Manaos, Brazil (Miss H. B. Merrill).

Adams (1905, Kans. Univ. Sci. Bull., 3) has reported the species from Rhodesia, South Africa. In view of the large number of known species similar in appearance to this one, a record from the Ethiopian region is doubtful unless very carefully checked up.

This species is very similar to *D. melanogaster* Meigen and to *D. caribbea* Sturtevant, especially in pinned material. In life the three species can be distinguished at a glance. *D. caribbea* is duller in color and stouter and more compressed laterally than are the other two. *D. willistoni* is more slender than *D. melanogaster*, and has much less distinct abdominal bands. In pinned material the three species may be recognized, as follows:

1. Acrostichal hairs in six rows .... *willistoni*
   Acrostichal hairs in eight rows 2
2. Costal index about 2.1; combs on male front tarsi .... *melanogaster*
   Costal index about 1.5; no combs on tarsi .... *caribbea*

This species is very common about fruit in the tropics. I have bred it from banana, grape-fruit, papaya, and pineapple. It is easily kept for many generations in the laboratory, banana serving as a convenient food. About two weeks are required for its development.

The chromosomes have been described by Metz (1916, Amer. Nat., 50; see p. 39 of this paper). The mating habits are described on page 7.

Drosophila melanogaster Meigen. 1830. Syst. Beschr., 6, 85. (Plate 3, fig. 2.)

D. nigriventris Zetterstedt. 1847. Dipt. Scand., 6, 2557. (Not Macquart. 1843. Dipt. Exot., 2, 3, 259).
D. ampelophila Loew. 1862. Berlin ent. Zeit., 6, 231.
D. uvarum Rondani. 1875. Bull. Com. agr. Parm.

♂. Arista with about five branches above and three below. Antennæ yellow. Front nearly one-half width of head, wider above; yellow. Second orbital one-third size of other two. Second oral bristle nearly as long as first. Carina rather broad, flat; face yellow. Cheeks yellow; their greatest width about one-fifth greatest diameter of eyes. Eyes with rather thick pile.

Acrostichal hairs in eight rows; no prescutellars. Mesonotum and scutellum shining reddish-yellow. Pleuræ and legs pale yellow. Apical and preapical bristles on first and second tibiæ, preapicals on third. A comb-like row of about ten short, curved black bristles on the inner distal surface of the basal tarsal segment of the first leg.

Abdomen shining black, with a basal reddish-yellow band on each of the first three segments.

Wings clear. Costal index about 2.2; fourth-vein index about 2.4; *5x* index about 2.0; *4c* index about 1.3.

Length body 2 mm.; wing 2 mm.

♀. Differs from the male only in having no tarsal combs, and in that there is a basal reddish-yellow band also on the fourth and fifth abdominal segments. All the yellow abdominal bands are frequently obscure in pinned specimens.

The sexual difference in the cheeks described by Loew I have been unable to detect.

Drosophila melanogaster is recorded in Europe from Sweden and England to France, Sardinia, Italy, and Austria. It is also recorded from Smyrna, Africa, and the Seychelles. I have examined material from Holland, France, Italy, Spain, Lourenco Marques, Hawaii, Australia, Chile, Brazil, and Bermuda. North American material examined is from Nova Scotia, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Maryland, District of Columbia, Virginia, Tennessee, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Texas, Arkansas, Missouri, Ohio, Indiana, Illinois, Wisconsin, Minnesota, South Dakota, Kansas, Wyoming, Washington, Oregon, California, Mexico, British Honduras, Costa Rica, Panama, Bahamas, Cuba, Jamaica, Porto Rico, Dominica, Barbados. This material includes the type material of *D. ampelophila* Loew. Live material has been kept in the laboratory and used in genetic experiments in which it was crossed with local races, from the following localities among others: Liverpool, Nova Scotia; Kushla, Alabama; Seattle, Washington; Claremont, California; Guantanamo, Cuba; Panama; Sydney, Australia. These races were all typical *D. melanogaster*, and were fertile with races from New York and Massachusetts and derivatives of crosses involving such stocks.

Although the species is not yet recorded from the oriental region outside of Australia, it may safely be considered as cosmopolitan. It is, however, apparently absent in the colder far-northern regions.

The species was described in 1830, from specimens taken in Austria and Germany (Kiel, Hamburg). Zetterstedt recorded it from Scandinavia (as *D. nigriventris*) in 1847, but stated that it was rare, as he had seen only two specimens. Loew, in 1862, redescribed it as *D. ampelophila*, and recorded it as occurring in Cuba and Africa, and in central Europe, while it was common in southern Europe. In 1864 he referred to it as common in the raisin stores of Smyrna. Schiner, in 1864, stated that it was common in Austria. The evidence is thus clear that the species was then common in parts of the Old World. After Loew described it from Cuba it does not seem to have been recorded in America until 1882, when Bowles (Canad. Ent., 14, 101) reported that he had seen it in 1879 at Montreal. Other records were then published, as follows: 1875, New York (Lintner); 1879, New Haven (Williston), Montreal (Bowles); 1882, Massachusetts, common (Williston).

It seems probable, as has been pointed out by Johnson (1913, Psyche, 20, 202) and others, that the species was introduced to this country from the tropics, and that it was not present or was rare in the days of Say, Harris, and Fitch. Fitch, especially, would scarcely have failed to note the species if it had been as common as it now is. His last report on the "Noxious and beneficial insects" of New York appeared in 1872; the last one in which he described new Diptera appeared in 1865. It seems fairly safe to conclude that *D. melanogaster* became common in upper New York State between 1865 and 1875.

It seems curious that the name *melanogaster* should have been overlooked by Loew, and should have been neglected by other workers for so long. It was recognized by Schiner in 1864, but seems not to have been used thereafter until Austen (1905, Entom. Mag., p. 276) pointed out that it was an earlier name for the form then known as *D. ampelophila* Loew. But even then the point was overlooked by most entomologists until rediscovered by Villeneuve (1913, Wien. ent. Zeit., 32, 128). The synonymy of *D. nigriventris* Zetterstedt was pointed out by Schiner (1864, Fauna Austr., 2, 277); that of *D. uvarum* Rondani by Mik (1883, Verh. zool.-bot. Ges. Wien., 33). Mik was also the first to conclude that the species is cosmopolitan.

D. melanogaster is to be found most commonly about houses or grocery stores, or in orchards or fields. It is not a common woods species. It seems to me doubtful if it hibernates in the Northern States. I suspect that the only survivors of the winter have lived indoors when it was cold. New stocks must be continually brought in from the tropics on banana boats, so that the race to be found in any one locality is very likely continually changing, through the introduction of "new blood." The species is primarily a fruit eater, though it can be bred on various other substances. Howard has bred it from human excrement, but this is exceptional, as the species is not usually attracted to such material. I have bred it from apple, banana, blackberry, fig, grapefruit, grape, guanabana, huckleberry, mariñon, papaya, peach, pineapple, plantain, potato, tomato, zapote, and stale beer. Banana and peach are the most satisfactory of these for laboratory purposes. A still more satisfactory method of feeding these flies in the laboratory is the banana-agar method described elsewhere in this paper.

The eggs have two filaments. Females will sometimes lay eggs when they are only a day old, but mating and oviposition usually begin on about the second or third day. From eight to twelve days are ordinarily required for development, depending on the temperature and food conditions. The chromosomes, mating habits, genetic experiments, and tropisms are described elsewhere in this paper.

Drosophila simulans Sturtevant. 1919. Psyche, 26, 153.

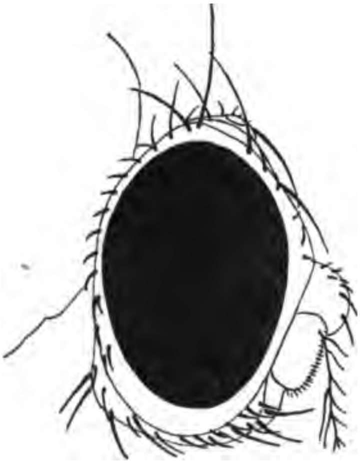
♂, ♀. No constant and usable differences from *D. melanogaster*, except that the cheek (measured just below the lowest point of the eye) is a little broader (*cf.* figs. 45 and 46), and that the shape of the clasper and of the posterior process of the first genital segment of the male (figs. 13 and 14) are distinct. The shape of the cheek is difficult to be sure of, and the male genitalia can not be examined satisfactorily except in relaxed material. The spermathecæ do not differ from those of *D. melanogaster*.

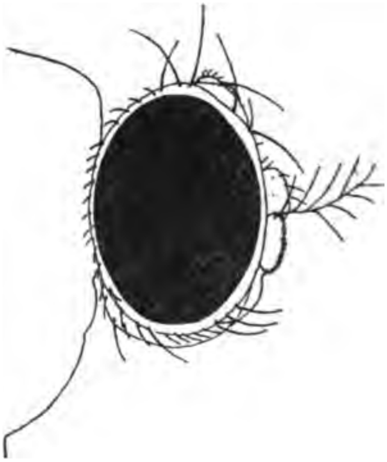
Specimens examined: Randolph, New Hampshire (Miss H. Daniels); Cold Spring Harbor (C. W. Metz), Staten Island (F. Schrader), New York; Rochester, Minnesota (L. Huckfield); Richmond, Virginia; Macon, Georgia (G. L. Carver); Lakeland (C. W. Metz, type material), Palm Beach (B. B. Horton), Key Largo (F. Knab), Florida; Kushla, Alabama; Fayetteville, Arkansas (B. Schwartz); Port Limon, Costa Rica; Taboga Island, Panama (A. Busck); São Paulo (F. Iglesias), Matto Grosso (Harris), Brazil.

The mating and breeding habits of this species are almost identical with those of *D. melanogaster*. The species is almost as common as *D. melanogaster* in the neighborhood of New York and in southern Alabama, but has not yet been recognized in material from the Pacific coast, the West Indies, Australia, Hawaii, or Europe, in all of which regions *D. melanogaster* is apparently common.

In life this species can be seen to be a little darker than *D. melanogaster* and a little stouter in shape. These differences are, however, not obvious unless a large series of each is examined. The eggs are quite different (see plate 1).

The genetic experiments with this species and its hybrids with *D. melanogaster* are described elsewhere in this paper (pp. 14 and 117).





HEAD OF MALE.

FIG. 45.—Drosophila melanogaster.

FIG. 46.—Drosophila simulans.

Since this species has not been distinguished from *D. melanogaster*, but is now common in the Eastern States in the same situations as that species, the same arguments as were applied to *D. melanogaster* may be shown to indicate that *D. simulans* is also an introduced form. Since it has not been recognized except from the United States, Central America, and Brazil, it seems very probable that it was brought in from the American tropics. The date of introduction was probably rather recent; of the specimens examined from this country the one from Key Largo is the only one collected before 1913, and that one was only a year or two earlier. Quackenbush (1910) was probably dealing with this species, in crosses with *D. melanogaster*. His material was collected at Woods Hole, Massachusetts, in 1908.

Drosophila caribbea Sturtevant. 1916. Ann. Ent. Soc. America, 9, 335.

♂, ♀. Arista with about five branches above and three below. Antennæ yellow, third joint brownish. Front nearly one-half width of head, wider above; reddish yellow. Second orbital about one-third other two. First oral bristle one and one-half times second. Carina rather broad, flat. Face, cheeks, and proboscis yellow. Greatest width of cheeks less than one-sixth greatest diameter of eyes. Eyes with thickly set, short pile.

Acrostichal hairs in eight rows; no prescutellars, although there is a transverse row of slightly enlarged hairs between the posterior pair of dorsocentrals. Mesonotum, scutellum, and pleuræ dull pale brownish-yellow. Legs pale yellow. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen brownish yellow, each segment with an indistinct brownish posterior margin.

Wings clear. Costal index about 1.5; fourth-vein index about 2.4; 5*x* index about 2.0; 4*c* index about 1.6.

Length body 2 mm.; wing 2.2 mm.

Specimens examined: Herradura (C. W. Metz), Havana (type material), Santiago de las Vegas, Baracoa (U. S. Nat. Mus.), Santiago de Cuba (C. W. Metz), Guantanamo (C. T. Ramsden, F. E. Lutz), Cuba; Sanchez, Haiti (F. E. Watson); Mayaguez, Porto Rico (F. E. Lutz); Antigua (H. A. Ballou); Roseau, Dominica (F. E. Lutz); Punta Gorda, British Honduras (U. S. Nat. Mus.); San Jose, Costa Rica; Taboga Island (A. Busck), Panama, Republic of Panama; Manaos, Brazil (Miss H. B. Merrill).

This species is quite common about fruit in Cuba and Central America. As I have pointed out elsewhere (1918, Journ. Parasitology, 5, 84), it is rather frequent about human excrement, and sometimes breeds on it. I have seen specimens bred from the feces of a dysentery patient in Cuba by Mr. J. R. Taylor. I have myself bred the species from banana, guava, mariñon, orange, papaya, pineapple, plantain, and zapote. About twelve days are required for its development. It can be bred in the laboratory through many generations with comparative ease, banana being a satisfactory food for this purpose.

The eggs have two filaments. An account of the chromosomes, of the mating habits, and of a mutation found in this species will be found elsewhere in this paper.

GROUP F.

Typical species. Subgroup 2: Blackish or grayish species.

Drosophila obscura Fallén. 1823. Dipt. Suec. Geomyz., 6, 6.

D. tristis Meigen. 1830. Syst. Beschr. (not Fallén. 1823. Dipt. Suec.).

♂. Arista with about four branches above and two below. Antennæ brown, third joint dark. Front over one-third width of head, wider above; opaque brown, orbits and ocellar triangle gray pollinose. Second orbital one-half other two. Second oral bristle about one-half size of first. Carina broad, high; face dark brown. Cheeks grayish brown, their greatest width about one-sixth greatest diameter of eyes. Eyes with rather thick pile.

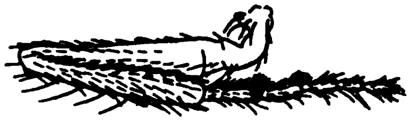


FIG. 47.—Drosophila obscura. Front leg of male, showing two tarsal combs.

Acrostichal hairs in eight rows; no prescutellars. Mesonotum, scutellum, and pleuræ dark dull grayish-brown, mesonotum sometimes slightly grayish pollinose. Legs pale brown, femora darker. There is a small comb of short, stout, curved black bristles on the inner side of each of the two basal joints of each front tarsus (fig. 47). Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen dark blackish-brown, somewhat shining toward the apex.

Wings clear, veins brown. Costal index about 2.7; fourth-vein index about 1.9; 5*x* index about 1.5; 4*c* index about 0.9.

Length of body 2.2 mm.; wing 2.3 mm.

♀. Agree, only no tarsal combs. In life show anterior pale bands on each abdominal segment.

Specimens examined: Italy (det. Bezzi); Holland (det. J. C. H. de Meijere); Corvallis (G. F. Sykes), Amity (D. E. Lancefield), Oregon; Berkeley (E. B. Babcock), Claremont (L. L. Gardner), Newport (C. W. Metz), California. The species is recorded in Europe from the Canary Islands to Sweden, Austria, and Italy. Coquillett (1899, Proc. U. S. Nat. Mus., 21, 301) recorded it from Japan, but an examination of his specimens has convinced me that they represent a different species of *Drosophila*.

This species is a fruit-feeding form. It is easily kept in the laboratory on banana, and has also been bred from pineapple, orange, and tomato. About two weeks are required for its development.

The eggs have two filaments. The chromosomes, mating habits, and certain genetic experiments are described elsewhere in this paper.

Drosophila affinis Sturtevant. 1916. Ann. Ent. Soc. America, 9, 334.

♂. Arista with about five branches above and two below. Antennæ brown, third joint nearly black. Front nearly one-half width of head, wider above; dark brown, lighter below, orbits and triangle pollinose. Second orbital three-fourths third, which is three-fourths first. Carina low, very narrow; face dull brown. Second oral bristle scarcely one-fifth first. Cheeks grayish brown; their greatest width about one-sixth greatest diameter of eyes. Eyes with short pile.

Acrostichal hairs in six rows; no prescutellars. Mesonotum, scutellum, and pleuræ coffee-brown. Legs pale brownish-yellow. A comb-like row of short, stout, curved black bristles on the inner side of the basal tarsal joint of each front leg, as in the male of *D. melanogaster* Meigen. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen dark brown, lighter toward the base.

Wings clear. Costal index about 3.6; fourth-vein index about 2.6; *5x* index about 2.0; *4c* index about 1.2.

Length body 2 mm.; wing 2.2 mm.

♀. As above, except that no tarsal combs are present. In life they have yellow anterior bands on each abdominal segment.

Specimens examined: Mount Washington (Mrs. Slosson), Hanover, New Hampshire; Beverly (Burgess), Woods Hole, Massachusetts; Niagara Falls (C. W. Johnson), Ithaca (E. G. Anderson), New York, Staten Island, New York; New Brunswick (F. E. Lutz), Fort Lee, Split Rock Pond, New Jersey; North Mountain, Pennsylvania (C. W. Johnson); La Fayette (J. M. Aldrich), Bloomington (F. Payne), North Manchester (R. R. Hyde), Indiana; Flat Rock, Illinois (F. N. Duncan); St. Louis, Missouri (W. V. Warner); Plummer's Island, Maryland (R. C. Shannon); Washington, District of Columbia (R. C. Shannon); Dead Run (R. C. Shannon), Richmond, Virginia; Knoxville, Tennessee (Aldrich coll.); North Carolina (U. S. Nat. Mus. coll.); Greenville, South Carolina; Georgia (U. S. Nat. Mus. coll.); Lakeland, Florida (C. W. Metz); Kushla, Alabama; Houston (H. J. Muller), Willis (U. S. Nat. Mus. coll.), Texas; Wister, Oklahoma (H. S. Barber); Douglas County, Kansas (coll. Univ. of Kans.).

This species has been often identified as the European *D. confusa* Staeger. A specimen from Italy in the collection of Mr. C. W. Johnson, identified as *D. confusa* by Bezzi and agreeing with the descriptions of that species, differs from this form as follows: acrostichal hairs in eight rows; two prominent oral bristles; fourth-vein index about 1.3. I have not seen any American specimens that seem to me to represent this species.

D. affinis feeds on fruit. I have bred it from banana, huckleberry, pineapple, potato, watermelon, and stale beer. It is not rare about bleeding trees. The development takes about two weeks.

The eggs have two filaments, slightly over one-half as long as the egg itself and somewhat dilated at their tips. The chromosomes have been described by Metz. Data on these, on the mating habits of the species, and on a mutation found in it by Hyde will be found elsewhere in this paper.

Drosophila pseudomelanica Sturtevant. 1916. Ann. Ent. Soc. America, 9, 333.

♂. Arista with about five branches above and three below. Antennæ brown. Front about one-third width of head, wider above; brownish red. Second orbital scarcely more than a hair. Second oral bristle two-thirds size of first. Carina flat, rather narrow. Face narrow, brown. Palpi brown, with several prominent bristles. Cheeks brown; their greatest width about one-sixth greatest diameter of eyes. Eyes with short pile.

Acrostichal hairs in six rows; no prescutellars. Mesonotum and scutellum dull blackish-brown. Pleuræ brown. Legs pale yellowish-brown. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen shining dark brown, basal segments with lighter median dorsal and anterior lines.

Wings clear, veins brown. Costal index about 4.0; fourth-vein index about 1.8; *5x* index about 1.3; *4c* index about 0.7.

Length body 1.5 mm.; wing 1.7 mm.

Specimens examined: Cabin John Bridge, Maryland, March 1914 (R. C. Shannon); Dead Run, Virginia, April 1914 (R. C. Shannon, type material).

Drosophila melanissima Sturtevant. 1916. Ann. Ent. Soc. America, 9, 333.

♂, ♀. Arista with about four branches above and two below. Antennæ velvety black. Front about one-half width of head, wider above; blackish brown, velvety. Second orbital about one-third other two. Second oral bristle less than one-fourth first. Carina broad, slightly sulcate below; face black. Several prominent palpal bristles. Cheeks brownish black; their greatest width about one-third greatest diameter of eyes. Eyes with short, thick black pile.

Acrostichal hairs long, in six rows; no prescutellars. Mesonotum, scutellum, and pleuræ brownish black; there is a faint grayish pollinose line extending from the base of the first coxa to the base of the haltere. Legs blackish brown. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen dark blackish brown, slightly polished.

Wings slightly brownish, veins brown. Costal index about 4.0; fourth-vein index about 1.7; *5x* index about 1.1; *4c* index about 0.7.

Length body 2 mm.; wing 2.2 mm.

Specimens examined: North Carolina (U. S. Nat. Mus.); Georgia (U. S. Nat. Mus.); Biscayne Bay, Florida (Mrs. Slosson); Kushla, Alabama (type).

As I have stated elsewhere (1918, Journ. N. Y. Ent. Soc., 26, 38), I found this species in large numbers about moist sawdust made from a living pine tree by a boring beetle, in Alabama, October 1916. Efforts to breed it were not successful, but there can be little doubt that the flies were breeding on this sawdust.

But for the broader cheeks, smaller eyes, and larger oral opening, this species might be considered as a dark-colored race of *D. melanica* Sturtevant.

Drosophila melanica Sturtevant. 1916. Ann. Ent. Soc. America, 9, 332. (Plate 3, fig. 3.)

♂, ♀. Arista with about four branches above and two below. Antennæ dark brown, second joint grayish above. Front over one-third width of head, wider above; blackish, velvety, orbits and narrow triangle brown. Second orbital about one-third size of other two. Second oral bristle less than one-fourth first. Carina broad, slightly sulcate; face blackish brown, dull. Several prominent palpal bristles. Cheeks brown; their greatest width about one-sixth greatest diameter of eyes. Eyes with short, thick black pile.

Acrostichal hairs long, in six rows; no prescutellar bristles. Mesonotum dull blackish-brown, a small indistinct pair of brown spots on anterior margin, just inside of dorsocentral lines. Humeri grayish brown. Scutellum and pleuræ dark dull blackish-brown. Legs, including coxæ, pale brown. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen yellow, with a pair of lateral dark-brown fasciæ on each segment.

Wings clear, veins brown. Costal index about 3.3; fourth-vein index about 1.7; *5x* index about 1.0; *4c* index about 0.8.

Length body 2 mm.; wing 2.2 mm.

Specimens examined: Mount Washington, New Hampshire (Mrs. Slosson); Plymouth (C. W. Johnson), Woods Hole, Massachusetts; Kingston, Rhode Island (C. W. Johnson); New York, New York; Bloomington, Indiana (F. Payne); Plummer's Island, Maryland (R. C. Shannon); District of Columbia (Loew collection); Dead Run, Virginia (R. C. Shannon); North Carolina (U. S. Nat. Mus. coll.); Macon, Georgia (G. L. Carver); Kushla, Alabama; Helena, Arkansas (H. S. Barber); Bethesda (R. H. Hutchison), St. Louis (J. F. Abbott), Missouri.

This is a fruit-eating form. I have bred it from banana and potato. In many places in the Eastern States it is the commonest of the woods species.

The eggs have two filaments. The chromosomes, reported by Metz, are described on page 39.

Drosophila robusta Sturtevant. 1916. Ann. Ent. Soc. America, 9, 331.

♂, ♀. Arista with about six branches above and three below. Antennæ dark brown, second joint pollinose distally. Front over one-third width of head, wider above; dark coffee-brown, orbits and triangle slightly grayish pollinose. Second orbital fine, about one-fourth length of other two. Second oral bristle not quite one-half size of first. More than one prominent bristle on each palpus. Carina broad, very slightly sulcate; face somewhat shining, brown. Cheeks brown, their greatest width scarcely one-sixth greatest diameter of eyes. Eyes with short pile.

Acrostichal hairs somewhat irregular, in six to eight rows; no prescutellars. Mesonotum dark dull-brown, with four faint pollinose longitudinal stripes. Scutellum and pleuræ dark dull-brown. Legs pale brown; first coxæ blackish brown beneath, with a whitish pollinose spot between them. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen grayish brown, each segment with a very broad dark-brown fascia on each side; these fasciæ often nearly or quite meet in the mid-dorsal line.

Wings clear, veins brown, subterminal part of first vein very dark. Costal index about 4.0; fourth-vein index about 1.6; 5*x* index about 1.2; 4*c* index about 0.7.

Length of body 2.5 mm.; wing 2.7 mm.

Specimens examined: Hanover, New Hampshire; Woods Hole, Massachusetts; Ithaca (S. W. Frost), Cold Spring Harbor (C. W. Metz), Staten Island (F. Schrader), New York; Cabin John Bridge, Maryland (R. C. Shannon); Falls Church, Virginia (N. Banks); Kushla, Alabama (type material); Helena, Arkansas (H. S. Barber).

This species is a fruit eater. I have bred it from banana, tomato, and potato. Nearly four weeks are required for its development.

The eggs have four filaments. The chromosomes, reported by Metz (1916, Amer. Nat., 50), are described on page 39; the mating habits will be found on page 7. The puparium has long anterior spiracles, and superficially resembles that of *D. immigrans* n. sp. on that account. The head is figured on page 25 (fig. 6).

Drosophila sulcata Sturtevant. 1916. Ann. Ent. Soc. America, 9, 330.

♂, ♀. Arista with about five branches above and two below. Antennæ reddish brown, third joint dark. Front over one-third width of head; reddish brown, with a dark-brown ocellar dot. Second orbital about one-fourth other two. Second oral bristle not quite one-half first. Three large bristles on each palpus. Carina prominent, not very broad, distinctly sulcate; face reddish brown. Cheeks reddish brown; their greatest width about one-fifth greatest diameter of eyes. Eyes with rather short, sparse pile.

Acrostichal hairs in six rows; no prescutellar bristles. Mesonotum grayish pollinose, with somewhat indefinite and variable reddish-brown interrupted stripes. These markings are easily obscured in imperfect specimens. Scutellum grayish pollinose. Pleuræ grayish pollinose, reddish-brown below. Legs, including coxæ, pale reddish-brown. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen grayish, with a dark-brown fascia on each side of each segment, leaving usually only a median dorsal and a posterior gray line.

Wings slightly yellowish, veins brown. Costal index about 4.6; fourth-vein index about 1.3; 5x index about 0.9; 4c index about 0.7.

Length body 3 mm.; wing 3.2 mm.

Specimens examined: Ottawa, Canada (W. H. Harrington); Franconia (Mrs. Slosson), Hanover (C. W. Johnson), Bretton Woods (C. W. Johnson), New Hampshire; Chester, Massachusetts (C. W. Johnson); Ithaca, New York (R. C. Shannon); Pottstown, North Mountain, Pennsylvania (C. W. Johnson); Cabin John Bridge (types), Linnieville, Maryland (R. C. Shannon); District of Columbia (U. S. Nat. Mus. coll.); Dead Run, Glencarlyn, Virginia (R. C. Shannon); Georgia (U. S. Nat. Mus. coll.).

Drosophila virilis Sturtevant. 1916. Ann. Ent. Soc. America, 9, 330.

♂, ♀. Arista with about five branches above and two below. Antennæ brown, third joint dark opaque reddish-brown. Front over one-third width of head, wider above; dull coffee-brown, ocellar dot black. Second orbital one-third other two. Second oral bristle three-quarters length of first. Only one long bristle on each palpus. Carina broad, slightly sulcate, noselike; face somewhat shiny, brown. Cheeks yellowish brown; their greatest width over one-fourth greatest diameter of eyes. Eyes pilose.

Acrostichal hairs in six rows; no prescutellars. Mesonotum and scutellum dark dull-brown. Pleuræ and abdomen dull brown, somewhat darker. Legs pale brown. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Wings clear, veins brown. Costal index about 2.8; fourth-vein index about 1.8; 5x index about 1.2; 4c index about 0.9.

Length body 2.8 mm.; wing 3.0 mm.

Specimens examined: New York, New York (types); Terre Haute, Indiana (R. R. Hyde). I have also one specimen, collected at St. Elmo, near Chattanooga, Tennessee (W. S. Adkins), that may belong here. The specimen is badly damaged, but agrees with this species so far as can be seen, except that the carina is not at all sulcate. It does not agree with any other species known to me. The New York record rests on a single pair bred from a pineapple exposed at Columbia University, in November 1913, and descendants of this pair. This stock is still being kept in large numbers by Dr. C. W. Metz, who has used it extensively in genetic experiments. The Terre Haute record rests on one series taken by Dr. R. R. Hyde in a grocery store, and likewise kept as a stock. I have seen living material of this strain. It is identical with the New York stock. The species is very hardy and easily kept in the laboratory. This fact makes its great rarity in nature surprising. The fact that both of the certain records are based on material collected about buildings suggests that the species may be an introduced one. It may well have been described under another name from some other region, though I have been unable to find any description with which it can be identified.

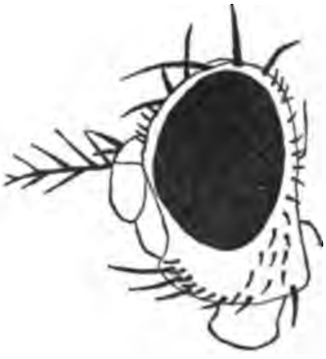


FIG. 48.—Drosophila virilis. Head.

The eggs have four filaments. The females ordinarily do not begin to lay until they are four or five days old. About three weeks are required for development. The mating habits, chromosomes, and genetic experiments dealing with this species are described elsewhere in this paper.

The small eyes and broad cheeks (fig. 48) make this species obviously distinct from such types as *D. robusta* (fig. 6) that resemble it superficially.

Drosophila earlei Sturtevant. 1916. Ann. Ent. Soc. America, 9, 329.

♂, ♀. Arista with about five branches above and two below. Antennæ brown, third joint dark. Front over one-third width of head, wider above; opaque reddish-brown, orbits and triangle grayish pollinose. Second orbital one-third other two. Second oral bristle nearly as long as first. Carina high and narrow; face brown. Cheeks yellowish brown; their greatest width about one-sixth greatest diameter of eyes. Eyes pilose.

Acrostichal hairs somewhat irregular, in six to eight rows; no prescutellar bristles. Mesonotum coffee-brown, with yellow-brown markings as follows: a narrow median longitudinal streak; a pair of longitudinal stripes including the dorsocentrals, and broader anteriorly with external branches behind; a spot on each humerus. Scutellum coffee-brown, with yellowish lateral edges. Pleuræ coffee-brown, legs pale brown. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen black, four basal segments each with an interrupted yellowish anterior band.

Wings clear, veins brown. Costal index about 2.0; fourth-vein index about 1.7; *5x* index about 1.3; *4c* index about 0.9.

Length body 2 mm.; wing 2 mm.

Specimens examined: Herradura (C. W. Metz, type material), Cristo (C. W. Metz), Cuba; Panama, Republic of Panama.

The eggs have two long filaments, that are broadened on their apical halves. The chromosomes, reported by Metz, are described on page 39.

This species will breed on banana and pineapple. It requires nearly a month for development.

Drosophila saltans Sturtevant. 1916. Ann. Ent. Soc. America, 9, 328.

♂, ♀. Arista with about five branches above and three below. Antennæ brown, third joint darker. Front over one-third width of head, wider above; reddish brown, triangle and orbits grayish pollinose, a brown spot above upper orbital bristle. Second orbital one-fifth other two. Second oral bristle nearly as long as first. Carina high and narrow; face brown. Proboscis brownish. Cheeks yellowish brown; their greatest width scarcely one-sixth greatest diameter of eyes. Eyes with short, sparse pile.

Acrostichal hairs in six rows; no prescutellars. Mesonotum grayish-brown pollinose, with markings of dark dull-brown as follows: a pair of short longitudinal stripes on the front margin, just within the dorsocentral rows; two pairs of spots just outside the dorsocentral rows, one just behind the humeri and the other just behind the transverse suture. Scutellum grayish-brown pollinose. Pleuræ dark brown, grayish at the sutures. Legs pale brown, femora and tibiæ darker in the middle. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen dark brown, each segment grayish pollinose anteriorly.

Wings with a small blackish speck at tip of first vein; otherwise clear. Costal index about 2.0; fourth-vein index about 2.6; *5x* index about 1.7; *4c* index about 1.4.

Length body 1.5 mm.; wing 1.7 mm.

Specimens examined: Guantanamo, Cuba (C. T. Ramsden, type material). Also specimens from Panama, Republic of Panama, that differ only in having lighter mesonotum.

This species can be bred for many generations on banana. It has also been bred on pineapple. The larvæ have the habit of "skipping," by the same mechanism as the familiar cheese-skipper (*Piophila*). In this respect they resemble *D. cardini* Sturtevant, a very different species.

Drosophila coffeata Williston. 1896. Trans. Ent. Soc. London, 409.

Arista with about four branches above and three below. Antennæ brownish, third joint darker. Front about one-third width of head, wider above; brown, with a pair of velvety black stripes converging below. Only one prominent oral bristle. Carina prominent, sulcate; face brown. Eyes with well-developed pile.

Acrostichal hairs in eight rows; no prescutellars. Mesonotum brown, with three narrow whitish longitudinal stripes. Scutellum and pleuræ dark brown. Legs yellow.

Abdomen blackish brown.

Wings very slightly smoky. Costal index about 2.5; fourth-vein index about 1.6; *5x* index about 1.2; *4c* index about 0.9.

Length body 1.4 mm.; wing 1.5 mm.

Specimen examined: St. Vincent, West Indies, 1,000 feet (Williston type material). The orbital bristles are missing on this specimen.

Drosophila annularis Sturtevant. 1916. Ann. Ent. Soc. Amer., 9, 327.

D. annulata Williston. 1896. Trans. Ent. Soc. London, 409 (not *Notiphila annulata annulata* Fallén. 1813. Vet. Akad. Hand.; *Drosophila annulata* Zetterstedt. 1847. Dipt. Scand. 6).

Front less than one-third width of head; dark brown, grayish pollinose on frontal stripes, a whitish spot above each antenna. Arista with about 7 branches above and 4 below. Antennæ yellowish, third joint darker above. Second orbital about one-fourth other two. Only one large oral bristle. Face blackish brown; carina noselike. Cheeks brown; their greatest width about one-fifth greatest diameter of eyes. Eyes with short, thick pile.

Acrostichal hairs in 8 rows; no prescutellars. Mesonotum dull brownish-black, with narrow irregular grayish markings in front, and a pair of faint blotches behind; humeri grayish. Scutellum dull black, its basal angles and apex grayish. Pleuræ brown, grayish pollinose. Femora brown, yellowish at tips; tibiæ yellow, each with a basal and an apical brown band; tarsi yellow. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen yellow, each segment with a broad posterior velvety black band. The bands on the third, fourth, and fifth segments are broken in the mid-dorsal line.

Cross-veins clouded; a black spot at tip of first vein. Costal index about 2.2; fourth-vein index about 1.5; 5*x* index about 1.0; 4*c* index about 1.0.

Length body 2.5 mm.; wing 2.5 mm.

Specimens examined: St. Vincent, West Indies, 1,500 feet (Williston type); Alajuelo, Panama (A. Busck). The St. Vincent specimen is headless.

Drosophila fasciola Williston. 1896. Trans. Ent. Soc. London, 410.

♂. Arista with about five branches above and three below. Antennæ yellowish brown, third joint darker. Front about one-third width of head, wider above; brown; vertex, orbits, and triangle yellowish. Second orbital about one-fourth other two. Only one prominent oral bristle. Carina narrow, flat; face yellowish brown. Cheeks brown; their greatest width about one-fifth greatest diameter of eyes. Eyes with short, thick pile.

Acrostichal hairs in six rows; no prescutellars. Mesonotum dull grayish-yellow, with numerous brown dots, the latter coalescing to form a broad median stripe and a pair of narrow anterior ones just inside the dorsocentral lines. Scutellum grayish yellow, each bristle arising from a brown dot. Pleuræ brown, slightly grayish pollinose. Legs pale brown; femora darker at base, and tibiæ with dark proximal and distal bands. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen brown, each segment yellowish at base.

Wings clear, tip of first vein black. Costal index about 1.8; fourth-vein index about 1.6; 5*x* index about 1.3; 4*c* index about 1.3.

Length body 2 mm.; wing 2.2 mm.

Specimen examined: St. Vincent, West Indies, 500 feet (Williston type).

Drosophila repleta Wollaston. 1858. Ann. Mag. Nat. Hist., 41, 117.

D. punctulata Loew. 1862. Berlin. ent. Zeit., 6, 232.
D. adspersa Mik. 1886. Wien. ent. Zeit., 5, 328.
? *D. nigropunctata* van der Wulp. 1892. Tijd. Ent., 34.
? *D. marmoria* Hutton. 1901. Trans. N. Zeal. Inst., 33, 91.

♂, ♀. Arista with about five branches above and three below. Antennæ grayish brown, third joint reddish. Front about one-half width of head, wider above; gray; each bristle arising from a dark-brown spot, and a pair of reddish-brown velvety lines converging below. Second orbital about one-third of other two. Only one prominent oral bristle. Carina distinctly sulcate; face brown. Cheeks yellowish brown; their greatest width about one-fourth greatest diameter of eyes. Eyes with thick pile.

Acrostichal hairs in eight rows; a pair of slightly enlarged hairs in the prescutellar position. In front of the dorsocentral bristles and in the same row with them are a few slightly enlarged hairs. Two large humerals. Mesonotum and scutellum gray, each bristle and hair arising from a dark-brown dot; these dots are irregularly fused into larger splotches, and there is also a dark-brown splotch on the disk of the scutellum. Pleuræ brown. Legs pale brown, first femora darker, first coxæ dark-brown below. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen gray, each segment with a wide interrupted dark-brown band on its posterior margin; these bands reach the anterior margin near the lateral edges of the segments, but, at least on the three basal segments, there is a gray spot between this point and the lateral margin.

Wings clear, first vein black at tip. Costal index about 3.4; fourth-vein index about 1.8; 5x index about 1.3; 4c index about 0.9.

Specimens examined: Vienna, Austria (Pokorny, det. Kertész); Barcelona, Spain (J. Arias); Lourenco Marques, Africa (C. W. Howard); Olaa, Hawaii (W. H. Ashmead); Fall River (N. S. Easton), Brookline (U. S. Nat. Mus. coll.), Massachusetts; Maspeth (Amer. Mus. Nat. Hist. coll.), New York, New York; Philadelphia, Pennsylvania (C. W. Johnson); Branchville, Maryland (F. E. L. Beal); Washington, District of Columbia (W. L. McAtee); Virginia, near Plummer's Island (R. C. Shannon); Black Mountains, North Carolina (N. Banks); Camp Jackson, South Carolina; Nashville, Tennessee (H. S. Barber); Daytona (B. B. Horton), Lakeland (C. W. Metz), Key West, Florida; New Orleans, Louisiana (P. Viosca); San Diego (E. A. Schwarz), Brownsville (Townsend), Texas; Tampico, Mexico (T. E. Holloway); Alajuelo (A. Busck), Panama, Republic of Panama; Guantanamo (C. T. Ramsden), Guareiras, Havana, Cuba; Sanchez, Haiti (F. E. Watson); Kingston, Jamaica (C. W. Johnson); Roseau, Dominica (F. E. Lutz); Posorja, Ecuador (F. Campos); Ceara, Brazil (F. D. da Rocha); Buenos Aires, Argentina (U. S. Nat. Mus. coll.); Bermuda (F. M. Jones).

Described from Madeira; recorded from the Seychelles by Lamb; from Italy, Gold Coast, Calcutta by Bezzi; from Austria and Ashantee by Mik; from Morocco by Becker. The type locality for *D. nigropunctata* is Java; that for *D. marmoria* is the Auckland Islands.

The descriptions of any of the species listed at the head of this section would fit the following two species as well as this one, except that *D. adspersa* could not well be *D. mulleri*. I have seen the type of *D. punctulata*, and it is the form here described. The two forms described next in this paper are not known to occur outside of the New World, while I have seen this one from two localities in Europe and one in Africa. Since all the names in question were applied to Palæarctic or Oriental specimens, it seems safe to suppose that this is the species involved. The types of *D. repleta* were collected about houses, which is in agreement with the habits of this form.

That the present species is distinct from the two following would certainly not be a legitimate conclusion from a study of ordinary pinned material, but has been abundantly demonstrated by breeding experiments. Neither of those species will cross at all with this one, though all are easily bred in the laboratory in pure stocks. In life the three forms are somewhat more different than appears from pinned material. The most conspicuous difference is in the color of the eyes. *D. mulleri* has bright red eyes, similar to those of the vermilion mutant of *D. melanogaster*. The other two forms have deeper, more brownish eyes. When old their eyes are much alike, but in young specimens *D. hydei* has a more reddish or wine-colored eye, *D. repleta* a deep sepia one. *D. repleta* averages somewhat larger in size than the other two, and breeds a little more slowly. Dr. Metz has shown that *D. repleta* and *D. mulleri* differ in the shape of their X chromosomes.

Drosophila repleta is evidently an introduced species in this country and in Europe. It is probably of tropical origin. The following dates represent the earliest authentic records for various parts of the world that are known to me: 1858, Madeira; 1862, Cuba; 1886, Austria, West Africa; 1892, Java (?); 1895, Fall River, Massachusetts; 1898, Philadelphia, Pennsylvania; about 1900, Hawaii; 1904, Nashville, Tennessee; 1909, Bermuda.

The mating habits of *D. repleta* are described on page 7; the spermatheca is figured on page 37; its mutations are discussed on page 14. This species will breed on fruit, and is attracted to human excrement (see Sturtevant, 1918).

Drosophila hydei, new species.

♀, ♂. No constant differences from *D. repleta* and *D. mulleri* except as follows: First coxæ pale brown below. No lateral gray areas on abdominal segments.

Type and gonotypes: from stock collected at Lakeland, Florida (C. W. Metz). As in the case of *D. immigrans*, the gonotypes are not descended from the type, but the whole type series is known to be descended from one individual.

Other specimens examined: Boston (C. W. Johnson), Woods Hole, Massachusetts; Providence, Rhode Island (C. W. Johnson); Riverton, New Jersey (C. W. Johnson); Frankford, Pennsylvania (C. W. Johnson); Bloomington (F. Payne), North Manchester (R. R. Hyde), Indiana; Coal Creek, Tennessee (W. S. Adkins); Flat River (T. Pergande), St. Louis (A. Busck), Missouri; St. Augustine (C. W. Johnson), Daytona (C. W. Johnson), Jacksonville (Mrs. Slosson), Miami, Florida; Kushla, Alabama; New Orleans, Louisiana (C. W. Metz); Willis, Texas (U. S. Nat. Mus. coll.); Berkeley (E. B. Babcock), Claremont (C. F. Baker), Newport (C. W. Metz), Spreckels (C. F. Stahl), California; Calabacillas, Chihuahua (S. McGibbon); Cuernavaca (C. C. Deam), Amatlan (F. Knab), State of Vera Cruz; Punta Gorda, British Honduras (J. D. Norton); Alajuelo, Panama (A. Busck); Nassau, Bahamas (coll. C. W. Johnson); Havana, Guareiras, Cuba; Cayey, Porto Rico (Lutz and Mutchler).

The species is named for Dr. R. R. Hyde, who first discovered that it is distinct from *D. repleta* in the color of the abdomen and that it will not cross with that species. I have verified these points and found the additional character of coxal color. As pointed out in the discussion of *D. repleta*, there is also a difference in eye-color and in average size that can be seen in life.

The mating habits of this species are discussed on page 6, and a mutation that Dr. Hyde has studied is listed on page 14. The eggs have four anterior filaments. The species will breed on fruit.

Drosophila hydei is evidently an introduced species in the United States, since it would have been mistaken for *D. repleta*, and we have already seen that that species was not known to the earlier collectors. The following dates are the earliest known to me for the species: 1891, St. Augustine, Florida; 1897, Frankford, Pennsylvania; 1900, State of Vera Cruz, Mexico; 1903, Willis, Texas; 1904, St. Louis, Missouri, and Providence, Rhode Island; 1905, Nassau, Bahamas.

Drosophila mulleri, new species.

D. repleta, variety *a*. Metz. 1916. Amer. Nat., 50, 595.

♂, ♀. No constant differences from *D. repleta* and *D. hydei* except as follows: First coxa pale brown below. Lateral gray areas present on abdominal segments as in *D. repleta*, often a little larger than in that species.

Type (♂) and four paratypes: Houston, Texas, 1915 (H. J. Muller).

Other specimens examined: Miami, Key Largo, Florida (F. Knab); Herradura (C. W. Metz), Havana, Guareiras, Aguada Pasajeros, Guantanamo (C. T. Ramsden), Cuba; Kingston, Jamaica (M. Grabham); Tegucigalpa, Honduras (F. J. Dyer).

The differences between this species and the two preceding ones that are available in living material are discussed under *D. repleta*. Its chromosomes are referred to on page 39. This form may be bred on banana.

Drosophila ramsdeni Sturtevant. 1916. Ann. Ent. Soc. America, 9, 328.

♂, ♀. Arista with about four branches above and two below. Antennæ pale yellow, third joint reddish brown above. Front pale yellow, three brown spots on each orbit and one around each ocellus. Second orbital one-fourth size of other two. First orbital three times size of second. Carina large, broad, sulcate. Face and cheeks yellow, a brown spot just below carina and one just below each eye. Eyes pilose.

Acrostichal hairs in eight rows; no prescutellars. Mesonotum light gray, each hair and bristle arising from a dark-brown spot. Between the dorsocentrals these spots are fused into a pair of irregular longitudinal stripes. Scutellum light gray, basal pair of bristles arising from brown spots. Pleuræ dark brown above, pale yellow below. Legs pale yellow, tips of femora and bases of tibiæ brown. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen yellow, each segment with a dark-brown cross-band, which is broadly broken in the mid-dorsal line.

Wings clear; veins pale brown, with dark-brown spots at tip of first vein and at junction of first and second veins. Costal index about 2.6; fourth-vein index about 2.0; 5*x* index about 1.2; 4*c* index about 1.1.

Length body 2.5 mm.; wing 2.5 mm.

Specimens examined: Guantanamo, Cuba (C. T. Ramsden, type material).

This species has been bred from pineapple.

The chromosomes, reported by Metz (1916, Amer. Nat., 50), are described on page 39.

Drosophila alabamensis Sturtevant. 1918. Journ. N. Y. Ent. Soc., 26, 38.

Arista with five branches above and one below. Antennæ large, brown; third joint large, oval, dark. Front about one-half width of head, wider above; brown, triangle and orbits grayish. "Second" orbital over one-half other two, placed a trifle below third. Only one prominent oral bristle. Carina very small, confined to upper part of face; face light brown. Proboscis brown, palpi dark brown, large. Cheeks brown; their greatest width about one-third greatest diameter of eyes. Eyes with short pile.

Acrostichal hairs in six rows; no prescutellar bristles. Mesonotum dull brown; humeri, median stripe, pair of stripes in dorsocentral rows, and posterior pair of stripes outside the latter and joining them at the suture, grayish. Scutellum brown, with grayish border. Pleuræ dull brown. Legs yellowish brown. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen dark dull brown.

Wings clear. Costal index about 2.3; fourth-vein index about 2.3; 5*x* index about 2.0; 4*c* index about 1.3.

Length body 2.3 mm.; wing 2.5 mm.

Specimen examined: Kushla, Alabama, April 9, 1915 (type).

Drosophila bilineata Williston. 1896. Trans. Ent. Soc. London, 409.

"♂. Front of equal width, not widened above; opaque velvety black, the orbits and a slender median line opaque yellowish-grey. Face light yellow, on the sides above dusted like the frontal orbits. Cheeks and the dilated palpi black, the cheeks yellow behind. Face distinctly receding, carinate in the middle. Antennæ brownish-yellow or brown, the third joint more than twice as long as wide; arista with about five rays above and three below. Occiput black above. Mesonotum and scutellum opaque deep-brown, the former with two narrow stripes, not reaching the hind margin, and appearing like continuations of the frontal orbits. Pleuræ light yellow. Abdomen oval, not elongate; opaque deep-brown or black, the fifth segment, except sometimes a small spot in the middle, the remainder of the abdomen [sic], and the narrow lateral margin of all the segments yellow. Legs light yellow. Wings greyish hyaline; ultimate section of the fourth vein not twice the length of the penultimate section. Length 1¾ mm.

"Three specimens. St. Vincent."

I have not seen this species, so have reproduced Williston's description verbatim.

GROUP G. MISCELLANEOUS SPECIES.

Drosophila vittatifrons Williston. 1896. Trans. Ent. Soc. London, 408.

Arista with about four branches above and one below. Antennæ yellow, third joint brownish. Front about one-third width of head, wider above; yellow, two dark-brown stripes converging below. Second orbital about three-fourths of other two. Only one prominent oral bristle. Carina large, not flat; face yellow. Proboscis yellow, palpi dark at tip. Cheeks yellow, with brownish spot below eyes.

Acrostichal hairs in six rows; no prescutellars. Mesonotum yellow, with four brown longitudinal stripes and an interrupted pair outside of these. Pleuræ and legs yellow.

Abdomen black, yellow at base and on sides.

Wings clear, except for a black spot at tip, reaching from second to fourth veins. Costal index about 2.2; fourth-vein index about 1.3; 5*x* index about 1.2; 4*c* index about 0.8.

Length body 2 mm.

Specimen examined: St. Vincent, West Indies, 1,500 feet (Williston type). The wing is figured by Williston (*loc. cit.*, plate XIII, fig. 152).

Drosophila guttifera Walker. 1849. List. Dipt. Ins., 4, 1110.

D. multipuncta Loew. 1866. Berlin. ent. Zeit., 10, 50.

♂, ♀. Arista with about six long branches above and four below. Antennæ brownish yellow, third joint darker above. Front nearly one-half width of head, wider above; yellow, ocellar spot darker. Second orbital about one-half other two. Three or four nearly equal oral bristles. Carina broad and flat, very slightly sulcate; face yellow. Cheeks yellow; their greatest width about one-third greatest diameter of eyes. Eyes thickly clothed with short pile.

Acrostichal hairs in six rows; no prescutellars. Mesonotum yellow, with four shining reddish-brown stripes, one pair in the acrostichal region and one including each dorsocentral line. Scutellum shining reddish-brown. Pleuræ yellowish-brown. Legs yellow, last joint of each tarsus brownish. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen shining dark yellowish-brown, each segment with four black spots on its posterior margin.

Wings with thirteen black spots, as follows: one at tip of second vein; one at junction of second and third veins; one on first section of third vein; one on anterior cross-vein; one at tip of third vein; three on third vein, dividing its last section into four nearly equal parts; one at each end of posterior cross-vein, these two united by a clouded region; one just before tip of fourth vein; one on fifth vein under the penultimate section of fourth vein; one in middle of last section of fifth vein. Costal index about 2.0; fourth-vein index about 1.5; 5*x* index about 1.3; 4*c* index about 1.1.

Length body 2 mm.; wing 2.2 mm.

Specimens examined: Monument Beach, Woods Hole, Massachusetts; Cape May, New Jersey (H. L. Viereck); Bloomington, Indiana (F. Payne); District of Columbia (Osten Sacken, type of *multipuncta*); Falls Church, Virginia (N. Banks); North Carolina (U. S. Nat. Mus. coll.); Gulfcrest, Kushla, Alabama; Fort Worth, Texas (W. S. Adkins). Walker described the species from Florida. It is rare in the northern part of its range, but much commoner in the southern part. I have seen only two New England specimens, but found it rather common in Alabama. It is apparently rare near Washington; Dr. Payne was able to get only one specimen at Bloomington; yet Mr. Adkins reports it not rare in Texas.

The species is to be found about fleshy fungi, from which both Mr. Adkins and I have bred it. Either gill-fungi or pore-fungi will serve for its development.

Drosophila calloptera Schiner. 1868. Novara.

♂, ♀. Arista with about seven long branches above and four below. Antennæ pale yellow. Front pale yellow; nearly one-half width of head, wider above. Second orbital minute. Only one prominent oral bristle. Carina broad and flat; face pale yellow. Cheeks brown; their greatest width about one-sixth greatest diameter of eyes. Palpi yellow, brownish at base; with three small apical bristles. Eyes with short, thick pile.

Acrostichal hairs in six rows; no prescutellars. Mesonotum velvety black, with a reddish-yellow spot in front, between the dorsocentral rows, a pair of narrow yellowish-gray median stripes, and an irregular grayish mark behind on each side; humeri yellowish. Scutellum dull grayish-black, velvety at base. Pleuræ blackish brown. Legs brown, femora darker. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen black, each segment with an interrupted gray basal band.

Wings with the following blackish areas: one including the basal portion of the wing, up to tip of first vein, and including also most of the area behind the fifth vein (a clear region from middle of first section of costa to apex of anal cell); one on anterior cross-vein; one in marginal cell, just above the last; one, connected with the first area mentioned by an infuscation, including the region of the posterior cross-vein, a U-shaped region with its ends in the costa and its base in the first posterior cell, and a process from this region that includes the apical half of the last section of the fourth vein; one at the tip of third vein. Costal index about 2.1; fourth-vein index about 1.2; 5*x* index about 0.7; 4*c* index about 0.7.

Length body 2.3 mm.; wing 2.5 mm.

Specimens examined: Havana, Cuba. Schiner described the species from material collected in "South America."

The chromosomes, reported by Metz, are described on page 39.

Drosophila calloptera ornatipennis Williston. 1896. Trans. Ent. Soc. London, 407 (as Drosophila ornatipennis, new species).

Like *D. calloptera* Schiner, except as follows: Mesonotum dark brown, pattern yellowish; legs yellow, femora usually brown; no spot in marginal cell above anterior cross-vein.

Specimens examined: St. Vincent, West Indies (Williston type material).

This species is figured in Williston's Manual of North American Diptera (1908, p. 300, fig. 5, wing).

I have given *ornatipennis* as a synonym of *calloptera* (1916, Ann. Ent. Soc. America, 9, 327), but a re-examination of the matter has convinced me that Williston's form is deserving of varietal rank.

Drosophila superba Sturtevant. 1916. Ann. Ent. Soc. America, 9, 342.

♀. Arista with eight branches above and four below. Antennæ brown, third joint dark. Front about one-third width of head, wider above; yellow. Second orbital scarcely more than a hair. Only one prominent oral bristle. Carina low and narrow, confined to upper part of face; face yellow. Cheeks yellow; their greatest width scarcely one-sixth greatest diameter of eyes. Eyes sparsely clothed with very short, fine pile.

Acrostichal hairs in about ten rows; no prescutellars; a single pair of dorsocentrals. Mesonotum yellow, with two pairs of interrupted brownish longitudinal stripes, the median pair broader than the outer. Scutellum brownish yellow. Pleuræ yellow, with two longitudinal dark reddish-brown stripes. Legs yellow. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen dark brown, yellow at base.

Wings brownish black, with four hyaline areas: one at base; one including the apical part of the costal cell and extending to the anal cell; a band extending directly across the wing about its middle, between the two cross-veins; a spot reaching from the middle of the first posterior cell to the wing-margin in the second posterior cell. Costal index about 3.0; fourth-vein index about 1.2; 5*x* index about 1.0; 4*c* index about 0.7.

Length of body 3 mm.; of wing 3.2 mm.

Specimen examined: Cacao, Trece Aguas, Alta Vera Paz, Guatemala (Schwarz and Barber). This specimen, in the U. S. Nat. Mus. collection, is the only one known, and is the type of the species.

Figure 49 shows the strikingly marked wing of this species.

Drosophila opaca Williston. 1896. Trans. Ent. Soc. London, 411.

♂, ♀. Arista with about eight branches above and three below. Antennæ blackish brown. Front over one-third width of head, wider above; velvety black. Second orbital minute. Only one prominent oral bristle. Carina narrow, confined to upper part of face; face blackish brown. Cheeks brown; their greatest width one-sixth greatest diameter of eyes. Eyes with very fine, sparse pile.

Acrostichal hairs in four rows; no prescutellars. Mesonotum and scutellum velvety black. Notopleural suture yellow; pleuræ velvety black down to a line from base of first coxa to haltere, pale yellow below this line. Legs pale yellow. Apical and preapical bristles on first and second tibiæ, preapicals on third.

Abdomen yellow, each segment with a posterior opaque black band that is wider at the sides.

Wings brownish tinged; veins dark brown, except at base, which is pale yellow. Costal index about 1.5; fourth-vein index about 1.8; *5x* index about 1.4; *4c* index about 1.3.

Length of body 1.5 mm.; of wing 1.5 mm.

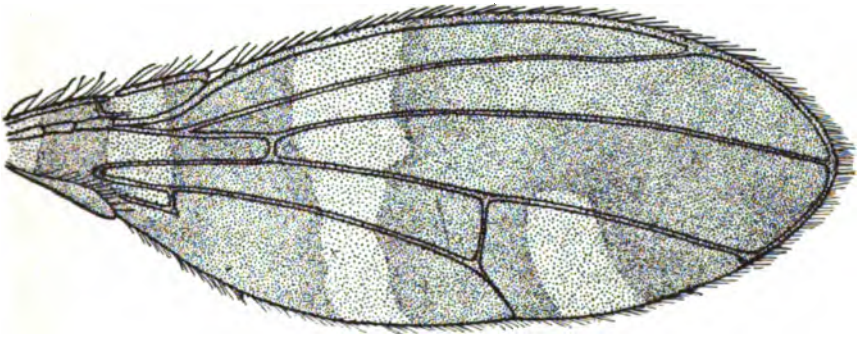


FIG. 49.—Drosophila superba. Wing of type specimen.

Specimens examined: St. Vincent, West Indies (Williston type material); Mayaguez, Porto Rico (F. E. Lutz); Port Antonio, Porus, Jamaica (C. W. Metz). Williston (1897, Kans. Univ. Quart., 6) has recorded the species from Brazil.

This species suggests *Mycodrosophila*, but can not go in that genus because it has two well-developed dorsocentral pairs, and because the thorax has not the shape characteristic of *Mycodrosophila*. It also resembles the group typified by *D. dubia*, but has large postverticals and is dull in color. The four acrostichal rows are aberrant, and suggest *Scaptomyza*, but this form resembles that genus in no other respect.

SPECIES OF DROSOPHILA RECORDED FROM NORTH AMERICA THAT ARE NOT LISTED ABOVE.

D. adusta Loew, to *Scaptomyza*.
D. albipes Walker, not recognizable from the description.
D. amœna Loew, to *Chymomyza*.
D. ampelophila Loew, synonym of *D. melanogaster* Meigen.
D. annulata Williston, new name is *D. annularis* Sturtevant.
D. apicata Thomson, to *Scaptomyza;* is a synonym of *D. terminalis* Loew.
D. bellula Williston, new name is *D. pulchella* Sturtevant.
D. bimaculata Loew, to *Leucophenga*.
D. brevis Walker, not recognizable from the description.
D. cellaris Linnæus, erroneous name for *D. funebris* Fabricius.
D. colorata Walker, not recognized. Suggests *D. sulcata* Sturtevant; and was so identified by Coquillett.
D. confusa Staeger, does not occur in North America. The material that has been so recorded is mostly *D. affinis* Sturtevant.
D. decemguttata Walker, probably is a *Diastata*.
D. dimidiata Loew, to *Mycodrosophila*.

D. excita Giglio-Tos is an ephydrid.

D. flaveola Meigen, to *Scaptomyza*. Does not occur in the region.

D. frontalis Williston, to *Leucophenga*.

D. fronto Walker, not recognizable from the description.

D. fusca Coquillett, not recognised. The type specimen has been lost, and it was the only one that Coquillett recorded. I have been unable to find any other material so labeled by him. The species, which was described from Porto Rico, suggests *D. lutzii* Sturtevant, but is stated to have only two orbitals. If this is correct the species is not one that I have seen.

D. graminum Fallén to *Scaptomyza*.

D. limbata Williston, new name is *D. nebulosa* Sturtevant.

D. linearis Walker, probably not a *Drosophila*. Suggests either *Scaptomyza* or a geomyzine.

D. maculosa Coquillett to *Leucophenga*.

D. mexicana Macquart, not recognised. The description would fit almost any large, dark species, and there are several such that probably occur in Mexico. This species can hardly be identified without an examination of the type.

D. minuta Walker, not recognizable from the description.

D. multipuncta Loew, synonym of *D. guttifera* Walker.

D. neglecta Sturtevant, a manuscript name for *D. melanica* Sturtevant, used by Metz (1916, Journ. Exper. Zool., 21, legend to plate 2).

D. nigricornis Loew, a manuscript name. It has gotten into the literature only through the description of a fungus said to have been found on it. This fungus, *Appendicularia entomophila* Peck (*Stigmatomyces entomophilus* Thaxter), was stated (1884, Science, 4, 25) to have been collected by Zabriskie at Nyack, New York, on a fly that was determined by H. A. Hagen, of Cambridge, as *D. nigricornis* Loew. From a specimen in the American Museum of Natural History and three in the Museum of Comparative Zoology at Cambridge it appears that the fly was really *D. funebris* Fabricius, on which the same fungus has been found in Europe (see Thaxter, 1895, Mem. Amer. Acad., 12, 300). Hagen evidently made his determination by comparison with specimens that are still in the Loew collection labeled "*D. nigricornis* Loew." These are evidently *Drosophila*, but not *D. funebris*. The only ones with locality label (D. C.) are *D. sulcata* Sturtevant and *D. melanica* Sturtevant.

D. obesa Loew to *Pseudophortica*.

D. obscuripennis Loew to *Leucophenga*.

D. orbitalis Sturtevant to *Zaprionus*.

D. pallida Williston, new name is *D. willistoni* Sturtevant.

D. pleuralis Williston to *Mycodrosophila*.

D. pollinosa Williston to *Paratissa* (Ephydrinæ).

D. procnemis Williston to *Chymomyza*.

D. projectans Sturtevant to *Mycodrosophila*.

D. punctulata Loew is a synonym of *D. repleta* Wollaston.

D. quadrimaculata Walker to *Leucophenga;* is a synonym of *D. varia* Walker.

D. slossonæ Coquillet, a manuscript name, used by Johnson (1913, Bull. Amer. Mus. Nat. Hist., 32, 88). I have been unable to find any specimens so named.

D. terminalis Loew to *Scaptomyza*.

D. thoracis Williston to *Mycodrosophila*.

D. valida Walker to *Minettia* (Lauxaniinæ). Is an earlier name for *Sapromyza macula* Loew.

D. varia Walker to *Leucophenga*.

D. vittata Coquillett to *Scaptomyza*.

Genera that Have Been Included in the Drosophilinæ but are not here so Considered.

Asteia Meigen. 1830. Syst. Beschr., 5, 88. Here considered as the type of a subfamily, the Asteinæ. This treatment is not new, but has recently been largely given up.

Crepidohamma Enderlein. 1915. Wien. ent. Zeit., 34, 185. Belongs in the Asteinæ, and is a synonym of *Sigaloessa* Loew.

Drosomyia de Meijere. 1904. Bijd. Dierk., 17, 114. De Meijere (1908, Tijd. Ent., 51 137) himself refers this genus to the Lauxaniinæ, making it a synonym of *Sapromyza*.

Echidnocephalus Lamb. 1914. Trans. Linn. Soc., 16, 351. This genus was described as being near *Liomyza*, and is accordingly to be referred to the Asteinæ.

Hypselothyrea de Meijere. 1906. Ann. Mus. Nat. Hung., 4, 193. This genus is to be referred to the Asteinæ.

Liomyza Meigen. 1838. Syst. Beschr., 7, 394. I am not familiar with this genus, but it appears to fit best in the Asteinæ. It is surely not a drosophiline, as that group is here defined.

Microperiscelis Oldenberg. 1914. Arch. Naturgesch., 80, A, 2. Near *Periscelis*, and therefore probably to be placed in the Agromyzinæ.

Monocera van der Wulp. 1898. Termes. Fuzetek., 21, 425. De Meijere (1914, Tijd. Ent., 57, 238) refers this genus to the Lauxaniinæ.

Paratissa Coquillett. 1900. Canad. Ent., 32, 36. This genus evidently belongs in the Ephydrinæ, where it is now usually placed.

Periscelis Loew. 1858. Berlin. ent. Zeit., 113, 2. Oldenberg has pointed out that this genus is scarcely to be considered as a Drosophiline. American specimens that I have examined seem to me to fit best in the Agromyzinæ.

Sigalæssa Loew. 1865. Berl. ent. Zeit., 120. Close to *Asteia*, and therefore to be placed in the Asteinæ.

Stenomicra Coquillett. 1900. Proc. U. S. Nat. Mus., 22, 262. The type seems to me to be a geomyzine, close to *Mumetopia*.

Uranucha Czerny. 1903. Wien. ent. Zeit., 22. Described as being near *Liomyza*. Is to be considered an asteine.

XI. GEOLOGICAL HISTORY.

According to Handlirsch (1906–1908), Diptera first appear in the Liassic; Cyclorrhapha not until the Lower Oligocene. In the latter period the Muscidæ acalyptratæ are already numerous, and are represented by nine subfamilies, all with species described as belonging to existing genera. The Lauxaniinæ, Ephydrinæ, Chloropinæ, and Drosophilinæ are among these subfamilies. The drosophiline, which is the only fossil member of the group known to me from the literature, is a form from Baltic amber recorded by Loew (1850) as "*Drosophila* sp." Loew did not describe the species, and it is to be noted that later (Loew, 1864) he referred to the subfamily as one "whose existence in amber is tolerably well established," as distinguished from others "now known certainly to occur in amber."

XII. GEOGRAPHICAL DISTRIBUTION.

Table 9 shows the number of species of each genus of the Drosophilinæ known from each of the main geographical regions. The Polynesian region is considered separately, because the data now available indicate that for this subfamily the fauna is more distinct from that of the rest of the world than is the fauna of any other region. This fact is probably due in large part to the incompleteness of the data, for the word "Polynesian" in this case means practically "Hawaiian Islands." The parts of the Oriental region nearest to these islands have not been well explored. Australia and New Zealand have been included in the Oriental region, again perhaps only because of a lack of data. These islands are practically unknown, so far as their drosophiline fauna is concerned. The same situation is found with respect to the relation of Madagascar to the Ethiopian region.

Table 9 indicates that the Nearctic region is the poorest of all in the number of species that it contains. The actual number recorded from the Ethiopian region is somewhat less than that from the Nearctic, but Africa has been very much less thoroughly collected than has the Nearctic region. A discussion of each region in some detail follows the table.

TABLE 9.—*Number of species of each genus in each region.*

Genus.	Nearct.	Neotr.	Palæ.	Ethiop.	Orient.	Poly.	Total.
Acletoxenus			1				1
Apsinota					3		3
Aulacigaster	1	1	1				1
Blæsochætophora		1					1
Camilla			2	1	4		7
Chymomyza	4	2	5	1			10
Cladochæta		1					1
Curtonotum	1	11	1	2	1		16
Dettopsomyia				1			1
Drosophila	28	41	43	22	51	44	203
Gitona			2		1	1	3
Idiomyia						6	6
Leucophenga	2	10	3	11	20		45
Mycodrosophila	1	3	1	3	1		9
Pseudiastata	1	1					1
Pseudophortica	1						1
Scaptomyza	3	2	10		2		15
Sinophthalmus	1						1
Stegana	2	5	9	1	12		28
Titanochæta						1	1
Zaprionus		1		1	1		3
Zygothrica		2			1		3
Total	45	81	78	43	97	52	360

NEARCTIC REGION.

This region is characterized by the presence of the two endemic genera *Pseudophortica* and *Sinophthalmus*. It has a relatively large number of species that also occur in other regions. The five cosmopolitan species (*Drosophila busckii, D. funebris, D. immigrans, D. melanogaster*, and *D. repleta*) are all recorded from this region. The following also occur in the Palæarctic region: *Aulacigaster leucopeza, Chymomyza caudatula, Drosophila obscura, D. transversa, Scaptomyza graminum*, and *Stegana coleoptrata. Scaptomyza terminalis* (Nearctic) and *S. unipunctum* (Palæarctic) may perhaps be identical. The following species are both Nearctic and Neotropical: *Chymomyza procnemis, Drosophila hydei, D. mulleri, D. simulans, Leucophenga maculosa*, and *Pseudiastata nebulosa. Drosophila mulleri* is perhaps better considered as a Neotropical species that occurs also in the borderland between the two regions; but I have included it here because it comes farther north than do most such species. Of the 45 species known from the region, this leaves only 28 as endemic.

The distribution of the 11 Nearctic genera within the region is as follows:

Aulacigaster: New Hampshire to Illinois, Kansas, Texas, and Alabama.
Chymomyza: New Hampshire to Washington, Texas, and Florida.
Curtonotum: Vermont to "North Red River" and Georgia.
Drosophila: Nova Scotia to British Columbia, California, and Florida.
Leucophenga: Massachusetts to Illinois, Kansas, Texas, and Florida.
Mycodrosophila: New Hampshire to Illinois, Alabama, and Georgia.
Pseudiastata: Maryland.
Pseudophortica: Virginia to Tennessee, Texas, and Florida.
Scaptomyza: Maine to Alaska, California, and Florida.
Sinophthalmus: California.
Stegana: Maine to Wisconsin, Arizona, and Florida.

This region has perhaps been more thoroughly collected in than any other, but our knowledge of the extreme northern part of it, and to a less extent of the western part, is still very incomplete. The following list, showing the species that are known from each of the States and provinces, will serve to illustrate this point. There are seven States from which no species at all are known: Delaware, Kentucky, Nebraska, North Dakota, Montana, Utah, and Nevada. Only a few States can be considered as at all thoroughly explored. It is likely that the list is fairly complete for New York, Alabama, Maryland, Massachusetts, Virginia, Indiana, New Hampshire, New Jersey, and Illinois. Florida is credited with more species than the two last named, but the Florida list as it stands includes five strictly Neotropical species (*Cladochæta nebulosa, Scaptomyza vittata, Drosophila cardini, D. lutzii*, and *D. willistoni*).

Alabama:
- Aulacigaster leucopeza.
- Pseudophortica obesa.
- Leucophenga varia.
- L. maculosa.
- Chymomyza amœna.
- C. procnemis.
- Mycodrosophila dimidiata.
- Scaptomyza adusta.
- S. graminum.

Alabama—continued.
- Drosophila affinis.
- D. alabamensis.
- D. busckii.
- D. funebris.
- D. guttifera.
- D. hydei.
- D. immigrans.
- D. melanica.
- D. melanissima.

Alabama—continued.
- D. melanogaster.
- D. putrida.
- D. quadrata.
- D. robusta.
- D. sigmoides.
- D. simulans.
- D. transversa.
- D. tripunctata.

- Arizona:
  - Stegana humeralis.
- Arkansas:
  - Drosophila melanica.
  - D. melanogaster.
  - D. robusta.
  - D. simulans.
- California:
  - Sinophthalmus pictus.
  - Scaptomyza terminalis.
  - Drosophila busckii.
  - D. funebris.
  - D. hydei.
  - D. immigrans.
  - D. melanogaster.
  - D. obscura.
  - D. quinaria ?
- Colorado:
  - Scaptomyza adusta.
- Connecticut:
  - Stegana coleoptrata.
  - Chymomyza amœna.
  - Drosophila busckii.
  - D. funebris.
  - D. melanogaster.
  - D. quinaria.
- District of Columbia:
  - Aulacigaster leucopeza.
  - Stegana humeralis.
  - Leucophenga maculosa.
  - L. varia.
  - Chymomyza amœna.
  - Mycodrosophila dimidiata.
  - Scaptomyza adusta.
  - S. graminum.
  - Drosophila affinis.
  - D. busckii.
  - D. funebris.
  - D. guttifera.
  - D. melanica.
  - D. melanogaster.
  - D. putrida.
  - D. repleta.
  - D. sulcata.
  - D. tripunctata.
- Florida:
  - Cladochæta nebulosa.
  - Stegana coleoptrata.
  - Pseudophortica obesa.
  - Leucophenga maculosa.
  - L. varia.
  - Chymomyza procnemis.
  - Scaptomyza adusta.
  - S. graminum.
  - S. vittata.
  - Drosophila affinis.
  - D. busckii.
  - D. cardini.
  - D. guttifera.
  - D. hydei.
  - D. immigrans.
- Florida—continued.
  - D. lutzii.
  - D. melanissima.
  - D. melanogaster.
  - D. mulleri.
  - D. repleta.
  - D. simulans.
  - D. willistoni.
- Georgia:
  - Curtonotum helva.
  - Pseudophortica obesa.
  - Leucophenga varia.
  - Chymomyza amœna.
  - Mycodrosophila dimidiata.
  - Drosophila affinis.
  - D. funebris.
  - D. melanica.
  - D. melanissima.
  - D. melanogaster.
  - D. putrida.
  - D. quadrata.
  - D. simulans.
  - D. sulcata.
- Idaho:
  - Chymomyza aldrichii.
  - Scaptomyza graminum.
  - S. terminalis.
  - Drosophila funebris.
  - D. quinaria ?
- Illinois:
  - Aulacigaster leucopeza.
  - Curtonotum helva.
  - Leucophenga maculosa.
  - L. varia.
  - Chymomyza amœna.
  - C. procnemis.
  - Mycodrosophila dimidiata.
  - Scaptomyza adusta.
  - S. graminum.
  - Drosophila affinis.
  - D. busckii.
  - D. duncani.
  - D. funebris.
  - D. inversa.
  - D. melanogaster.
  - D. putrida.
  - D. sigmoides.
  - D. transversa.
  - D. tripunctata.
- Indiana:
  - Aulacigaster leucopeza.
  - Curtonotum helva.
  - Stegana humeralis.
  - Leucophenga maculosa.
  - L. varia.
  - Chymomyza amœna.
  - Mycodrosophila dimidiata.
  - Scaptomyza adusta.
  - S. graminum.
  - Drosophila affinis.
  - D. busckii.
- Indiana—continued.
  - D. funebris.
  - D. guttifera.
  - D. hydei.
  - D. inversa.
  - D. melanica.
  - D. melanogaster.
  - D. putrida.
  - D. quadrata.
  - D. quinaria.
  - D. transversa.
  - D. tripunctata.
  - D. virilis.
- Kansas:
  - Aulacigaster leucopeza.
  - Leucophenga maculosa.
  - L. varia.
  - Chymomyza amœna.
  - C. procnemis.
  - Scaptomyza adusta.
  - S. graminum.
  - Drosophila affinis.
  - D. busckii.
  - D. funebris.
  - D. melanogaster.
- Louisiana:
  - Leucophenga varia.
  - Chymomyza amœna.
  - Scaptomyza adusta.
  - S. graminum.
  - Drosophila busckii.
  - D. hydei.
  - D. immigrans.
  - D. melanogaster.
  - D. repleta.
  - D. tripunctata.
- Maine:
  - Stegana coleoptrata.
  - Scaptomyza terminalis.
  - Drosophila putrida.
  - D. transversa.
- Maryland:
  - Aulacigaster leucopeza.
  - Curtonotum helva.
  - Pseudiastata nebulosa.
  - Stegana humeralis.
  - Leucophenga maculosa.
  - L. varia.
  - Chymomyza amœna.
  - Mycodrosophila dimidiata.
  - Scaptomyza adusta.
  - S. graminum.
  - Drosophila affinis.
  - D. busckii.
  - D. funebris.
  - D. immigrans.
  - D. melanica.
  - D. melanogaster.
  - D. pseudomelanica.
  - D. putrida.
  - D. quinaria.

- Maryland—continued.
  - D. repleta.
  - D. robusta.
  - D. sigmoides.
  - D. sulcata.
  - D. transversa.
  - D. tripunctata.
- Massachusetts:
  - Aulacigaster leucopeza.
  - Curtonotum helva.
  - Stegana coleoptrata.
  - S. humeralis.
  - Leucophenga varia.
  - Chymomyza amœna.
  - Mycodrosophila dimidiata.
  - Scaptomyza adusta.
  - S. graminum.
  - Drosophila affinis.
  - D. busckii.
  - D. funebris.
  - D. guttifera.
  - D. hydei.
  - D. immigrans.
  - D. inversa.
  - D. melanica.
  - D. melanogaster.
  - D. ordinaria.
  - D. putrida.
  - D. quinaria.
  - D. repleta.
  - D. robusta.
  - D. sulcata.
  - D. transversa.
- Michigan:
  - Chymomyza amœna.
  - Drosophila funebris.
- Minnesota:
  - Drosophila busckii.
  - D. funebris.
  - D. inversa.
  - D. melanogaster.
  - D. simulans.
- Mississippi:
  - Drosophila melanogaster.
  - D. putrida.
- Missouri:
  - Chymomyza amœna.
  - Drosophila affinis.
  - D. hydei.
  - D. melanica.
  - D. melanogaster.
- New Hampshire:
  - Aulacigaster leucopeza.
  - Stegana coleoptrata.
  - S. humeralis.
  - Chymomyza amœna.
  - C. procnemis.
  - Mycodrosophila dimidiata.
  - Scaptomyza adusta.
  - S. graminum.
  - S. terminalis.
- New Hampshire—continued.
  - Drosophila affinis.
  - D. busckii.
  - D. funebris.
  - D. inversa.
  - D. melanica.
  - D. melanogaster.
  - D. ordinaria.
  - D. putrida.
  - D. quinaria.
  - D. robusta.
  - D. simulans.
  - D. sulcata.
  - D. transversa.
- New Jersey:
  - Curtonotum helva.
  - Stegana coleoptrata.
  - S. humeralis.
  - Leucophenga varia.
  - Chymomyza amœna.
  - Mycodrosophila dimidiata.
  - Scaptomyza adusta.
  - S. graminum.
  - Drosophila affinis.
  - D. busckii.
  - D. funebris.
  - D. guttifera.
  - D. hydei.
  - D. immigrans.
  - D. inversa.
  - D. melanogaster.
  - D. putrida.
  - D. quinaria.
  - D. transversa.
  - D. tripunctata.
- New Mexico:
  - Drosophila funebris.
  - D. quinaria ?
- New York:
  - Aulacigaster leucopeza.
  - Curtonotum helva.
  - Stegana coleoptrata.
  - S. humeralis.
  - Leucophenga maculosa.
  - L. varia.
  - Chymomyza amœna.
  - C. procnemis.
  - Scaptomyza adusta.
  - S. graminum.
  - S. terminalis.
  - Drosophila affinis.
  - D. busckii.
  - D. funebris.
  - D. immigrans.
  - D. inversa.
  - D. melanica.
  - D. melanogaster.
  - D. putrida.
  - D. quinaria.
  - D. repleta.
  - D. robusta.
- New York—continued.
  - D. sigmoides.
  - D. simulans.
  - D. sulcata.
  - D. transversa.
  - D. tripunctata.
  - D. virilis.
- North Carolina:
  - Curtonotum helva.
  - Leucophenga maculosa.
  - L. varia.
  - Chymomyza amœna.
  - Mycodrosophila dimidiata.
  - Drosophila affinis.
  - D. guttifera.
  - D. melanica.
  - D. melanissima.
  - D. melanogaster.
  - D. repleta.
  - D. sigmoides.
- Ohio:
  - Drosophila funebris.
  - D. immigrans.
  - D. melanogaster.
  - D. quinaria.
- Oklahoma:
  - Drosophila affinis.
- Oregon:
  - Drosophila busckii.
  - D. funebris.
  - D. melanogaster.
  - D. obscura.
- Pennsylvania:
  - Aulacigaster leucopeza.
  - Stegana humeralis.
  - Leucophenga maculosa.
  - L. varia.
  - Chymomyza amœna.
  - C. procnemis.
  - Mycodrosophila dimidiata.
  - Drosophila affinis.
  - D. busckii.
  - D. hydei.
  - D. putrida.
  - D. quinaria.
  - D. repleta.
  - D. sulcata.
- Rhode Island:
  - Curtonotum helva.
  - Stegana coleoptrata.
  - S. humeralis.
  - Chymomyza amœna.
  - Drosophila funebris.
  - D. hydei.
  - D. melanica.
  - D. melanogaster.
  - D. putrida.
  - D. quinaria.
- South Carolina:
  - Chymomyza amœna.

- South Carolina—continued.
    - Scaptomyza adusta.
    - S. graminum.
    - Drosophila affinis.
    - D. immigrans.
    - D. melanogaster.
    - D. putrida.
    - D. repleta.
    - D. tripunctata.
- South Dakota:
    - Drosophila funebris.
    - D. melanogaster.
- Tennessee:
    - Pseudophortica obesa.
    - Leucophenga varia.
    - Scaptomyza graminum.
    - Drosophila affinis.
    - D. hydei.
    - D. melanogaster.
    - D. putrida.
    - D. repleta.
    - D. sigmoides.
    - D. transversa.
    - D. virilis ?
- Texas:
    - Aulacigaster leucopeza.
    - Pseudophortica obesa.
    - Leucophenga maculosa.
    - Chymomyza amœna.
    - Scaptomyza adusta.
    - S. graminum.
    - Drosophila affinis.
    - D. guttifera.
    - D. hydei.
    - D. melanogaster.
    - D. mulleri.
    - D. quinaria ?
    - D. repleta.
    - D. sigmoides.
- Vermont:
    - Curtonotum helva.
    - Stegana coleoptrata.
    - S. humeralis.
    - Chymomyza amœna.
    - Scaptomyza adusta.
    - S. graminum.
    - Drosophila funebris.
    - D. inversa.
    - D. putrida.
    - D. quinaria.
- Virginia:
    - Aulacigaster leucopeza.
    - Curtonotum helva.
    - Stegana coleoptrata.
    - S. humeralis.
    - Pseudophortica obesa.
    - Chymomyza amœna.
    - C. procnemis.
    - Scaptomyza adusta.
    - S. graminum.
    - Drosophila affinis.
    - D. busckii.
    - D. funebris.
    - D. guttifera.
    - D. melanica.
    - D. melanogaster.
    - D. pseudomelanica.
    - D. putrida.
    - D. quinaria.
    - D. repleta.
    - D. robusta.
    - D. sigmoides.
    - D. simulans.
    - D. sulcata.
    - D. transversa.
    - D. tripunctata.
- Washington:
    - Chymomyza caudatula.
    - Scaptomyza graminum.
    - S. terminalis.
    - Drosophila funebris.
    - D. inversa.
    - D. melanderi.
    - D. melanogaster.
    - D. quinaria ?
- West Virginia:
    - Leucophenga varia.
    - Scaptomyza graminum.
    - Drosophila busckii.
    - D. putrida.
- Wisconsin:
    - Stegana coleoptrata.
    - Drosophila funebris.
    - D. melanogaster.
- Wyoming:
    - Drosophila melanogaster.
- Alaska:
    - Scaptomyza terminalis.
- Alberta:
    - Drosophila funebris.
- British Columbia:
    - Scaptomyza graminum.
    - S. terminalis.
    - Drosophila funebris.
- Nova Scotia:
    - Drosophila melanogaster.
- Ontario:
    - Stegana humeralis.
    - Drosophila sulcata.
- Quebec:
    - Scaptomyza terminalis.
    - Drosophila funebris.
    - D. melanogaster.
    - D. ordinaria.
    - D. quinaria.

NEOTROPICAL REGION.

There are two endemic Neotropical genera—*Blæsochætophora* and *Cladochæta*. The region is also characterized by the large number of species of the genus *Curtonotum*, which is apparently rare in all other parts of the world. The 5 cosmopolitan species of *Drosophila* and the 6 species previously mentioned as occurring also in the Nearctic (*Chymomyza procnemis*, *Drosophila hydei*, *D. mulleri*, *D. simulans*, *Leucophenga maculosa*, and *Pseudiastata nebulosa*) are the only Neotropical species also known to occur elsewhere. Adams has recorded *Drosophila willistoni* (as *D. pallida* Williston) from Rhodesia; but in view of the large number of closely similar species in this group, this identification can not be accepted as final. This leaves 71 of the 82 recognized species as endemic.

The distribution of the 13 Neotropical genera within the region is as follows:

Aulacigaster: "West Indies."
Blæsochætophora: Cape Horn.
Chymomyza: Florida, Cuba, and Panama to Matto Grosso.
Cladochæta: Porto Rico to Cuba, Florida, and Mexico.
Curtonotum: Mexico to Peru, Brazil, and British Guiana.
Drosophila: Florida and Bahamas to Argentina, Chile, and Mexico.
Leucophenga: Florida and Cuba to Paraguay, Peru, and Honduras.
Mycodrosophila: Isle of Pines to Trinidad.
Pseudiastata: Panama.
Scaptomyza: Florida and Cuba to Patagonia, Peru, and Mexico.
Stegana: Cuba to St. Vincent, Peru, and Mexico.
Zaprionus: Panama.
Zygothrica: Panama to Peru and Brazil.

The West Indian islands of Cuba and St. Vincent and the region of the Panama Canal have been fairly thoroughly explored, but our knowledge of the rest of the region is very incomplete. Mexico and the whole South American continent especially need investigation.

The following list shows species known from various subdivisions of the region. South America has been treated as a single unit only because our knowledge of it is so slight. Some Neotropical species will be found on the Florida list, given in the section on the Nearctic region.

Drosophila fusca Coquillett (Porto Rico), *D. mexicana* Macquart (Mexico), and the South American species *D. atra* Walker, *D. gigantea* Thomson, *D. sphærocera* Thomson, and *D. tarsalis* Walker have all been omitted as being either unrecognizable or probably not members of the genus *Drosophila*.

Antigua:
  Drosophila caribbea.
Bahamas:
  Drosophila willistoni.
  D. melanogaster.
  D. hydei.
Barbados:
  Drosophila melanogaster.
  D. nebulosa.
  D. similis.
British Honduras:
  Drosophila caribbea.
  D. hydei.
  D. melanogaster.
Costa Rica:
  Curtonotum sp.
  Stegana sp.
  Scaptomyza vittata.
  Drosophila alfari.
  D. cardini.
  D. caribbea.
  D. floræ.
  D. immigrans.
  D. lutzii.
  D. melanogaster.
  D. simulans.
  D. tristani.
Costa Rica—continued.
  D. willistoni.
Cuba:
  Cladochæta nebulosa.
  Stegana sp.
  Leucophenga bimaculata.
  L. frontalis.
  L. maculosa.
  L. obscuripennis.
  Chymomyza procnemis.
  Scaptomyza vittata.
  Drosophila bromeliæ.
  D. busckii.
  D. calloptera.
  D. cardini.
  D. caribbea.
  D. dubia.
  D. earlei.
  D. flexa.
  D. floræ.
  D. hydei.
  D. lutzii.
  D. melanogaster.
  D. metallica.
  D. metzii.
  D. mulleri.
  D. nebulosa.
Cuba—continued.
  D. poeyi.
  D. ramsdeni.
  D. repleta.
  D. saltans.
  D. similis.
  D. splendida luteipes.
  D. torrei.
  D. willistoni.
Dominica:
  Drosophila cardini.
  D. caribbea.
  D. melanogaster.
  D. repleta.
Guatemala:
  Drosophila superba.
Hispaniola:
  Leucophenga maculosa.
  Chymomyza sp.
  Mycodrosophila projectans.
  Drosophila cardini.
  D. caribbea.
  D. nebulosa.
  D. prognatha.
  D. repleta.
  D. willistoni.

Honduras:
  Leucophenga frontalis.
  Drosophila dubia.
  D. floræ.
  D. mulleri.
  D. similis ?
Isle of Pines:
  Mycodrosophila thoracis.
Jamaica:
  Scaptomyza vittata.
  Drosophila lutzii.
  D. cardini.
  D. melanogaster.
  D. mulleri.
  D. opaca.
  D. repleta.
  D. similis.
  D. sororia.
  D. willistoni.
Mexico:
  Curtonotum gibbum.
  C. simplex.
  Cladochæta nebulosa.
  Stegana sp.
  Scaptomyza sp.
  Drosophila funebris.
  D. hydei.
  D. lutzii.
  D. melanogaster.
  D. repleta.
  D. similis ?
Nicaragua:
  Drosophila flexa.
Panama:
  Pseudiastata nebulosa.
  Zygothrica aldrichii.
  Z. dispar.
  Zaprionus orbitalis.
  Chymomyza procnemis.
  Drosophila albirostris.
  D. annularis.
  D. cardini.
  D. caribbea.
  D. earlei.
  D. flexa.
  D. hydei.
Panama—continued.
  D. melanogaster.
  D. nana.
  D. nebulosa.
  D. repleta.
  D. saltans.
  D. simulans.
  D. willistoni.
Porto Rico:
  Cladochæta nebulosa.
  Leucophenga frontalis.
  Scaptomyza vittata ?
  Drosophila cardini.
  D. caribbea.
  D. floræ.
  D. hydei.
  D. lutzii.
  D. melanogaster.
  D. nebulosa.
  D. opaca.
  D. prognatha.
  D. willistoni.
St. Vincent:
  Stegana horæ.
  S. scutellaris.
  S. tarsalis.
  Leucophenga frontalis.
  Chymomyza procnemis.
  Mycodrosophila pleuralis.
  M. thoracis.
  Drosophila annularis.
  D. bilineata.
  D. calloptera ornatipennis.
  D. coffeata.
  D. fasciata.
  D. illota.
  D. nana.
  D. nebulosa.
  D. opaca.
  D. pulchella.
  D. similis.
  D. sororia.
  D. splendida.
  D. verticis.
  D. vittatifrons.
  D. willistoni.
South America:
  Curtonotum apicale Hendel.
  C. bathmedum Hendel.
  C. decumanum Bezzi.
  C. fumipenne Hendel.
  C. gibbum.
  C. impunctatum Hendel.
  C. murinum Hendel.
  C. simplex Schiner.
  C. tæniatum Hendel.
  C. trypetipenne Hendel.
  C. vulpinum Hendel.
  Blæsochætophora picticornis.
  Zygothrica dispar.
  Stegana acutangula.
  S. magnifica.
  Leucophenga argenteiventris.
  L. argenteofasciata.
  L. brunneipennis.
  L. hasemani.
  L. maculosa.
  L. ornativentris.
  L. undulata.
  Chymomyza procnemis.
  Chymomyza sp.
  Scaptomyza sp.
  Drosophila calloptera.
  D. caribbea.
  D. melanogaster.
  D. opaca.
  D. pulchra Schiner.
  D. repleta.
  D. simulans.
  D. soror Schiner.
  D. tarsata Schiner.
  D. willistoni.
Trinidad:
  Chymomyza procnemis.
  Mycodrosophila projectans.
  Drosophila funebris.
  D. paradoxa.
  D. pulchella.
  D. siimlis ?

PALÆARCTIC REGION.

The Palæarctic has one endemic genus, *Acletoxenus*. The two genera *Curtonotum* and *Mycodrosophila* are each represented by a single species that occurs in southern Europe, and are perhaps newcomers from the Ethiopian or Oriental regions. The 5 cosmopolitan species of *Drosophila* and the 6 species (*Aulacigaster leucopeza*, *Chymomyza caudatula*, *Drosophila obscura*, *D. transversa*, *Scaptomyza graminum*, and *Stegana coleoptrata*) that also occur in the Nearctic are the only ones that are known to occur outside of the region. This leaves 67 of the 78 recognized species as endemic.

The following list shows the distribution of the 11 genera within the region, so far as I have been able to determine it by an examination of the literature:

Acletoxenus: England to Austria and Hungary.
Aulacigaster: Scotland and Sweden to France, Italy, and Hungary.
Camilla: Scotland and Sweden to Greece, Italy, and the Canaries.
Chymomyza: Lapland to Siberia, Hungary, and Germany.
Curtonotum: Southern France to Galicia and Italy.
Drosophila: Canary and Faroe Islands to Egypt and Japan.
Gitona: Germany and Austria to Tunis and the Canaries.
Leucophenga: England and Sweden to Hungary, Italy, and France.
Mycodrosophila: Hungary to southern Russia.
Scaptomyza: Canary and Faroe Islands to Egypt and Austria.
Stegana: Sweden and England to France, Hungary, and western Russia.

Most of Europe has been thoroughly collected, and the Canary Islands and Madeira are known from Becker's papers. The rest of the region is unknown except for a few scattering records.

ETHIOPIAN REGION.

The genus *Dettopsomyia* is endemic. There are probably one or two endemic genera among the species described as Drosophilæ by Lamb, as that author has pointed out. The region is, so far as known, characterized by the absence of the genus *Scaptomyza*. Of the 43 species here recognized, 39 are endemic. The other 4 (*Drosophila busckii*, *D. funebris*, *D. melanogaster*, and *D. repleta*) are cosmopolitan. The fifth species that is here considered as cosmopolitan, *D. immigrans*, has not yet been recognized from the Ethiopian region, but may be expected.

The 9 Ethiopian genera have the following recorded distribution within the region:

Camilla: Kongo.
Chymomyza: Seychelles.
Curtonotum: Senegal and Cameroon to Cape Colony.
Dettopsomyia: Seychelles.
Drosophila: Eritrea to Ashantee, Rhodesia, Mauritius, and Seychelles.
Leucophenga: Cameroon, Rhodesia, Seychelles.
Mycodrosophila: Seychelles.
Stegana: Kongo.
Zaprionus: Senegal to Eritrea, Rhodesia, and the Seychelles.

Lamb has given a full and valuable account of the fauna of the Seychelles. Kahl has presented some data on a few species from Cameroon, and Adams has described a few species from Rhodesia. Aside from these the region is known only from a few scattered references. It must certainly contain a large number of undescribed species.

ORIENTAL REGION.

The genus *Apsinota* and the doubtfully valid genus *Thaumastophila* are endemic in the Oriental region. So far as the published descriptions and the specimens that I have seen show, the genus *Chymomyza* is absent. Four of the 5 cosmopolitan species of *Drosophila* occur in Australia at least; and the fifth, *D. repleta*, is probably to be recognized in *D. marmoria* Hutton (New Zealand) and *D. nigropunctata* van der Wulp (Java). It is recorded from Calcutta (Bezzi). *Gitona perspicax* Knab occurs both in the Oriental region and in Hawaii. This leaves 91 of the total of 97 recognized species as endemic.

The 11 genera are distributed as follows within the region:

Apsinota: Formosa, Java, New Guinea.
Camilla: Java.
Curtonotum: Philippines.
Drosophila: New Zealand to Philippines, Java, and India.
Gitona: India, Philippines.
Leucophenga: Australia to Formosa, Java, and the Nicobars.
Mycodrosophila: Java.
Scaptomyza: Java.
Stegana: New Guinea to Formosa and Ceylon.
Zaprionus: Java, India.
Zygothrica: Simalu (off Sumatra).

Australia and New Zealand have been included here only because our present knowledge of them makes any other treatment out of the question. The total number of species described from them is 10, of which 4, or probably 5, are cosmopolitan, while the descriptions of 3 of the others are quite inadequate. Only 2 genera (*Drosophila* and *Leucophenga*) are represented. New Guinea is also hard to classify, as only 6 species of the subfamily are recorded from it. These 6 species belong to the genera *Apsinota* (1), *Drosophila* (3), *Leucophenga* (1), and *Stegana* (1). Two of these are Walker species and therefore doubtful. The same species of *Apsinota* is also recorded from Java.

De Meijere has described more than 60 oriental species of Drosophilinæ, mostly from Java, with a few from Sumatra and Simalu. Formosa and the Philippines are fairly well known. The rest of the region is practically unexplored. There must be very many undescribed species in India, the Malay peninsula, Borneo, and other parts of the region.

POLYNESIAN REGION.

With the exception of *Drosophila coffeina* Schiner, from Tahiti, all the Polynesian records are from the Hawaiian Islands.[*] The genera *Idiomyia* and *Titanochæta* are endemic. None of the other genera of the subfamily are recorded except *Drosophila* and *Gitona*, and the latter is perhaps introduced. Only 3 of the 5 species here considered to be cosmopolitan are recorded—*Drosophila immigrans*, *D. melanogaster*, and *D. repleta*. *Gitona perspicax* Knab, which also occurs in the Oriental region, is the only other species known from any other region. This leaves 48 of the 52 species as endemic.

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[*] I had overlooked the fact that Jepson (1917, Ann. Rept. Div. Ent., Dept. Agric. Fiji, 1916, 16) records *Drosophila melanogaster* from Fiji.

There is no reason to suppose that the subfamily is not present in the other Pacific islands, but it has not been recorded from them.* With respect even to the Hawaiian Islands, Perkins (Fauna Haw., 1, clxxxix) says "Not less than 250 species [of Drosophilinæ] must exist in the islands, and very probably double that number may occur." The number and variety of Drosophilinæ form the most striking peculiarity of the dipterous fauna of these islands. Nearly one-third of the species of Diptera considered by Perkins to be endemic in the islands belong to this subfamily. There are a number of large and strikingly colored species of true *Drosophila*, as I have convinced myself by an examination of material in the U. S. National Museum. Besides the two endemic genera mentioned above, there is a genus described by Grimshaw under the name *Hypenomyia* that is perhaps distinct, but is here tentatively placed as a synonym of *Drosophila*, in the absence of a satisfactory description.

XIII. SPECIES HYBRID.

Drosophila melanogaster and *D. simulans* are the only two species of Drosophilinæ that have been hybridized (see p. 14). The two species are extremely similar in appearance, and there is every reason for believing that they are closely related. This fact makes the hybrids less interesting for study than would be the offspring of two quite diverse species. In addition, the hybrids so far obtained have all been completely sterile, so that their genetic behavior can not be studied. Nevertheless, there are several facts of considerable interest in connection with the cross.

In general, the hybrids are intermediate in appearance between the two parent species. This is true of the relative size of the eyes and width of the cheeks and of the male genitalia. The other differences between the species, except the length and shape of the egg-filaments, are too indefinite for exact study; and the hybrid females do not lay eggs, so that this character can not be observed. The hybrids differ from both parent species in several respects, as follows:

1. They are completely sterile, and have poorly developed gonads.
2. The abdominal plates often are irregular and have narrower and more irregular dark bands than are usual.
3. Some of the thoracic bristles are usually missing.
4. The wings are apt not to unfold properly, or to be somewhat less convex on the anterior margin than is usual.
5. The cross-veins are often broken or missing.

The most peculiar thing about these hybrids, however, is the distribution of the sexes. The crosses usually result as follows:

D. melanogaster ♀ × *D. simulans* ♂ = hybrid ♀ ♀ only.
D. simulans ♀ × *D. melanogaster* ♂ = hybrid ♂ ♂; occasionally a few hybrid ♀ ♀.

If the *D. melanogaster* females bear a Y chromosome (XXY), and therefore give non-disjunctional exceptions, it is found that they produce, by *D. simulans* males, only regular daughters and exceptional sons. The exceptional daughters and regular sons die. In every case it has been possible to determine, by means of sex-linked genes, that the female hybrids carry two X chromosomes, the males only one X, as is the case in both parent species.

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* I had overlooked the fact that Jepson (1917, Ann. Rept. Div. Ent., Dept. Agric. Fiji, 1916, 16) records *Drosophila melanogaster* from Fiji.

The hybrid females from the two crosses first mentioned must have the same chromosomal constitution; yet in one case they live, while in the other they usually die. This can only mean that the result is due to an interaction between the chromosome complex and the egg cytoplasm in which it finds itself, unless selective fertilization occurs. It seems probable that in this case, as in other instances in which the cytoplasm plays a part in the result, the nature of the cytoplasm is itself determined by the chromosome complex of the female that produced the egg.

These data indicate that the two species differ in a number of genes. Not only are they slightly different in appearance in a number of ways, but the same end-results (viability, fertility, bristle-number, abdominal banding, wing-shape, venation) must be brought about by somewhat different sets of genes in the two species, since when both sets are present in the same animal the end result is different from that which either one alone would produce.

As stated above (p. 14) mutations have been found in *D. simulans* that appear to be identical with previously known ones in *D. melanogaster*, and in five cases crosses have shown that the mutant genes in the two species are allelomorphic. Four of these are sex-linked, and have the same linear sequence in the two species, though they do not show quite the same frequencies of crossing-over. This furnishes a demonstration that the germ-plasms of two distinct species contain some identical genes that are subject to identical mutations.

XIV. SPECIFIC DIFFERENCES VS. MUTATIONAL DIFFERENCES.

An examination of the keys given in this paper will show that the differences most frequently used are those involving the number and relative sizes of the bristles, the details of venation, the color of the wings, of the mesonotum, and to a less extent of other parts of the body, and the arrangement of the hairs. Other characters in which marked differences exist in the living animals include eye-color, wing-shape, abdominal pattern, the size and shape of the eyes, and the genitalia of both sexes.

Bridges (1919) has estimated the relative frequency of certain types of viable mutants in *D. melanogaster*. He finds that about 25 per cent of the mutant genes studied have affected the wings (size, shape, or venation), about 20 per cent the color of the eyes, and about 16 per cent the general body-color. The two next most frequent types are undoubtedly those affecting the number, size, or distribution of the bristles or hairs, and those affecting eye-shape or texture.

There is a large psychological factor in the data relating to the characters in which species differ, and also in the results obtained by Bridges for mutant characters. The keys are drawn up to fit pinned material, so that eye-colors or genitalia, which usually can not be studied in such material, are at once eliminated. In studying specific differences it often becomes necessary to examine minute characters, such as wing-vein indices or the relative sizes of certain bristles, that are seldom examined in material bred for genetic purposes. The shape of the carina is an excellent specific character, but is difficult to examine in unpinned material; no mutations in it have been observed. Similarly, the immature stages and the food and mating habits, that differ markedly among the species, have never been really examined for mutations.

For these reasons it is not practicable to compile statistics showing the relative frequency of occurrence of different kinds of characters among the species and among the mutations. We can, however, see if the mutant characters that have been observed are similar to characters found in wild species. That many of them are similar will appear from the following list of special cases. This list is by no means complete, but includes enough striking cases to illustrate the point under discussion.

SPECIFIC CASES OF PARALLELISM BETWEEN MUTANT CHARACTERS AND CHARACTERS OF WILD SPECIES.

Size: The species of *Drosophila* differ considerably in size, ranging from about 1 mm. to about 6 mm. in length. Among the mutant characters of *D. melanogaster* are at least two dwarfs and one giant, and in *D. simulans* a dwarf is known. These mutants are to all appearances perfectly normal, except in size.

Eyes: The size of the compound eye shows great variation from species to species. Figures 45 and 48 will illustrate this point. Similarly, the mutant "eyeless" in *D. melanogaster* has eyes that are smaller than those of the wild type. (As the name indicates, the eyes of this form are sometimes entirely gone.) Other mutant forms with small eyes are also known, as well as a few in which the eyes are larger than those of the parent race.

The wild species of *Drosophila* differ greatly in eye-color; and practically all the colors found in them may be matched among the mutants of *D. melanogaster*. *D. repleta*, *D. virilis*, and *D. funebris* have eyes that suggest the purple or sepia mutants; *D. willistoni* and *D. immigrans* are nearer scarlet or vermilion among the mutants.

Bristles: The bristles of *D. lutzii* are decidedly smaller than those of most species; this condition is paralleled by a number of mutant races in several species. The postverticals are missing in *Aulacigaster* and in the mutant races of *D. melanogaster* known as "scute" and "hairless." The vibrissæ are missing in *Apsinota*, in *Idiomyia*, and in the subfamily Chloropinæ, and elsewhere. Mr. D. E. Lancefield has discovered a mutant race of *D. obscura*, known as "deformed," in which these bristles are missing. The anterior dorsocentrals are missing (or hair-like) in *Mycodrosophila*, in *Drosophila superba*, and in the mutant race of *D. melanogaster* known as "two-bristle."

Hairs: Hairs are present on the disk of the scutellum and on the mesopleura in the genus *Curtonotum* (and *Apsinota* ?) and in the mutant race of *D. melanogaster* known as "hairy." A few bristles occur on the mesopleuræ of *Aulacigaster* and *Camilla;* aside from these and the usual four scutellar bristles I know of no other instances in the subfamily in which these parts bear bristles or hairs.

Color: The general body-color of many of the wild species is darker than that of *D. melanogaster*, of others paler and more yellowish. The same is true of the mutant races, but it is difficult to match definite species with given mutant colors, because the patterns are usually somewhat different. Dark, smoky wings occur in such species as *D. nebulosa*, *D. inversa*, *D. annularis*, *D. opaca*, and *D. robusta*. In these forms the pigment is usually diffuse, but more concentrated along the veins. Somewhat smoky wings with darker clouds along the veins also occur in the mutant races "black" and "ebony."

Wings: Slight differences in the shape of the wings are characteristic of many of the wild species. *D. immigrans*, for example, has distinctly narrower wings than has *D. melanogaster*. Similar slight differences occur among the mutants. The types "broad" and "expanded" in *D. melanogaster* and "pointed" in *D. funebris* are examples.

The numerous small wings among the mutants are of two different types. In the first type ("miniature" in *D. melanogaster*, "short" in *D. immigrans*, etc.), the parts are all present, but the wing is built on a small plan. This type occurs in nature in such forms as the borborine *Speomyia* (Bezzi. 1914, Zool. Anz., 44, 504–506) and the scatopsid *Coboldia* (Melander. 1916, Bull. Wash. Agr. Exper. Sta., 130, 20). In the second mutant type of wing, parts are missing. One gets the impression that pieces have been cut away, leaving a part of a normal wing. Characteristic examples are "vestigial," "strap," and "beaded" in *D. melanogaster*. The geomyzine *Mutilloptera* (figured by Melander, 1916, Psyche, 20, 169) suggests strap, and the chironomid *Eretmoptera* (Kellogg, 1905, Amer. Ins. p. 311) and the tipulid *Chionea* (Washburn, 1905, Dipt. Minn. p. 38) suggest vestigial.

In some of the Phoridæ (*e. g.*, *Pulicophora*, see Williston, 1908, Man. N. Amer. Dipt., p. 236) and in the mutant race "apterous" the wings are entirely missing.

Many of the mutant races differ from the wild type in venation. Some of these are similar to forms found in nature.

In "plexus" and in "blistered" the fourth vein bends forward sharply at its apex, as in the trypetine *Anastrepha*.

In "notch" the third vein is thicker than the second and fourth, as in *Chlorops* and related genera (Chloropinæ).

In "short," a mutant race of *D. obscura*, the fifth vein does not extend beyond the posterior cross-vein. In "hairless" and "abrupt" in *D. melanogaster* it extends a short way beyond the cross-vein, but not to the wing-margin. These conditions can be matched in different species of the borborine genus *Borborus*.

In "fused" *D. melanogaster* the third and fourth veins are more or less convergent at their apices, suggesting *Phortica* and several other muscid types.

In cross-veinless a mutant race of *D. virilis*, the posterior cross-vein is missing, as in the asteine *Asteia* and the agromyzine *Phytomyza*.

In "short" *D. immigrans* the costa is not broken at the apex of the first vein. This character occurs in several acalypterate subfamilies.

Legs: In the mutant race "bent," of *D. melanogaster*, the basal tarsal joints are often short and thick, resembling those of the Borborinæ.

In "bithorax" *D. melanogaster* the hind leg often bears an apical bristle like that of the middle leg. This bristle, however, is usually strongly curved and greatly resembles the "hind tibial spur" of the chloropine genus *Hippelates*.

We may conclude from these data that mutations do frequently bring about changes similar to those found in wild species. The general impression gained from considerable experience with both types of animals is that specific differences may be found in practically any character studied, and that the same is true of mutational differences. Mutational differences may be of almost any degree, ranging from types that differ so slightly that statistical methods are necessary for the detection of any differences at all, to such extreme forms as the eyeless or wingless races. "Superficial" characters, such as eye-color or bristle-size, are affected as frequently as are such "fundamental" ones as the differentiation between the mesothoracic and metathoracic segments, the reaction to light, or the fertility or the viability of the individual.

There are, however, marked differences between the diversity shown by the mutant races of a single species and the diversity shown by wild species of a small group. The species usually differ slightly from each other in innumerable characters, but are not strikingly different in any characters. The mutant races, on the other hand, are alike in most of the details of their structure, but often differ strikingly in a few characters.

These facts do not indicate that specific and mutational differences are different in origin and kind. Any considerable experience with mutant races will convince one that the viability of a mutant race is, on the average, inversely proportional to the degree of its difference from the parent race. In other words, the greater the change produced by the mutation the more likely it is to interfere with the proper functioning of the organism. An organism is an extremely delicately adjusted mechanism, and any random change in it might be expected to decrease the efficiency of the whole. Furthermore, the greater the change the greater is the damage that is likely to result. It follows, then, from actual observation as well as from theoretical considerations, that mutations which bring about slight changes are least likely to be harmful and therefore are most likely to become incorporated into the race. This gives an explanation for the observed fact that specific differences are usually slight ones. The reason that the observed mutational differences are often of much greater degree is very simple; when such changes do occur they are easily discovered and are convenient to work with, so that they are artificially selected and perpetuated even if their viability or productivity is inferior to that of the parent race.

That species commonly differ in more respects than do mutant races must mean that they differ in more inherited factors than do mutant races. Mutant races are usually known to differ significantly from the parent race in only one or a very few genes. That species differ from each other in many genes is, in the case of *Drosophila* or any form in which fertile hybrids are not known, only an inference.* Such a situation would, however, be pretty certain to arise as a result of long-continued isolation. In the case of the species of *Drosophila* that have been studied, interspecific sterility constitutes an effective mechanism for bringing about isolation. As to the origin of the interspecific sterility itself, we can only speculate until we know more about the mechanism whereby such sterility is now brought about.

Species, then, differ from each other in many genes. The differences, though numerous, are such that each produces only a slight effect on the organism. These differences are of the same kind as are the mutational differences, and may be supposed to have arisen by mutation.

The picture of evolution that this analysis leads to is in effect not very different from that which Darwin drew. Species change gradually, by the slow accumulation of numerous slight mutational differences. The possibility of a sudden change of considerable degree is always present, but will not usually be realized, because such a change will generally give rise to an imperfectly adjusted organism.

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* This point has, however, been demonstrated in the case of certain species hybrids among plants. Compare Baur (1919, Zeits. ind. Abst. Vererb., 21, 48–52) and Lotsy (1912, Zeits. ind. Abst. Vererb., 8, 325–333) on *Antirrhinum;* Wichler (1913, Zeits. ind. Abst. Vererb., 10, 177–232) on *Dianthus;* Kristofferson (1914, Botan. Notis., pp. 25–31, abstract in Zeits. ind. Abst. Vererb., 14, 34) on *Viola;* van der Stok (1910, Teysmannia, 21, 47–59, abstract in Zeits. ind. Abst. Vererb., 4, 153) on corn-teosinte hybrids; East (1916, Genetics, 1, 311–333) on *Nicotiana.*

XV. CATALOGUE OF DESCRIBED SPECIES OF DROSOPHILINAE.

(Only the type localities are given.)

- **ACLETOXENUS** Frauenfeld. 1868. Verh. zool.-bot. Ges. Wien, 28; 158.
  - **A. formosus** Loew. 1846. Wien. ent. Monatsschr., 8; 366. Europe.
  - *A. syrphoides* Frauenfeld. 1868. Verh. zool.-bot. Ges. Wien, 28; 152. Is a synonym of *A. formosus* Loew.
- **AMIOTA** Loew. 1862. Berlin. ent. Zeit. 6. (See *Stegana*.)
- **AMPHYCOPHORA** Wahlberg. 1847. K. Svensk. Vet. Akad. Förh. 1847; 261. (See *Aulacigaster*.)
- **APOTOMELLA** Dufour. 1845. Ann. Soc. Ent. France 1845; 455. (See *Aulacigaster*.)
- **APSINOTA** van der Wulp. 1887. Tijd. Ent. 30; 178.
  - **A. hyalipennis** Hendel. 1914. Suppl. Ent. 3; 112 (*Thaumastophila*). Formosa.
  - **A. obscuripes** de Meijere. 1911. Tijd. Ent. 54; 416. Java.
  - **A. pictiventris** van der Wulp. 1887. Tijd. Ent. 30; 178. Java.
- **AULACIGASTER** Macquart. 1835. Suit. Buff. 2; 579.
  - **A. leucopeza** Meigen. 1830. Syst. Beschr. 6; 100 (*Diastata*). Europe.
  - *A. rufitarsis* Macquart. 1835. Suit. Buff. 2; 580. Is a synonym of *A. leucopeza*.
- **BLÆSOCHÆTOPHORA** Czerny. 1904. Wien. ent. Zeit. 206.
  - **B. picticornis** Bigot. 1888. Miss. scient. Cap Horn, 6 (*Leria*). Cape Horn.
- **CAMILLA** Haliday. 1838. Ann. Nat. Hist. 2; 188.
  - **C. acutipennis** Loew. 1865. Berlin. ent. Zeits. 9; 269. Europe.
  - **C. africana** Bezzi. 1908. Ann. Soc. Ent. Belg. 52; 388. Kongo.
  - **C. cœruleifrons** de Meijere. 1911. Tijd. Ent. 54; 421. Java.
  - **C. glabra** Fallén. 1823. Dipt. Suec. Geomyz., 8 (*Drosophila*). Europe.
  - **C. javana** de Meijere. 1911. Tijd. Ent. 54; 422. Java.
  - **C. pusilla** de Meijere. 1911. Tijd. Ent. 54; 423. Java.
  - **C. rugulosa** de Meijere. 1914. Tijd. Ent. 57; 269. Java.
- **CHYMOMYZA** Czerny. 1903. Zeits. Hymenopt. Dipt. 3; 3; 199.
  - **C. albopunctata** Becker. 1900. Act. Scient. Fenn. 26 (*Drosophila*). Siberian Nikander Island.
  - **C. aldrichii** Sturtevant. 1916. Ann. Ent. Soc. Amer. 9; 325. Idaho.
  - **C. amœna** Loew. 1862. Berlin. ent. Zeit. 6 (*Drosophila*). United States.
  - **C. bicolor** Lamb. 1914. Trans. Linn. Soc. Lond. 16; 348. Seychelles.
  - **C. caudatula** Oldenberg. 1914. Arch. Naturgesch. 80; A. Europe.
  - **C. costata** Zetterstedt. 1838. Ins. Lapp. 776; 5 (*Drosophila*). Europe.
  - **C. distincta** Egger. 1862. Verh. zool. bot. Ges. 12 (*Drosophila*). Europe.
  - **C. fuscimana** Zetterstedt. 1838. Ins. Lapp. 776; 6 (*Drosophila*). Europe.
  - **C. procnemis** Williston. 1896. Trans. Ent. Soc. London 1896; 412 (*Drosophila*). West Indies.
- **CLADOCHÆTA** Coquillett. 1900. Proc. U. S. Nat. Mus. 22; 263.
  - **C. nebulosa** Coquillett. 1900. Proc. U. S. Nat. Mus. 22; 264. West Indies.
- **CURTONOTUM** Macquart. 1843. Dipt. Exot. 2; 3; 193.
  - **C. anus** Meigen. 1830. Syst. Beschr. 6; 95 (*Diastata*). Europe.
  - **C. apicale** Hendel. 1913. Deutsch. ent. Zeit. 1913; 621. Peru.
  - **C. arenata** Osten Sacken. 1882. Berlin. ent. Zeit. 1882; 26 (*Diplocentra*). Philippines.
  - **C. bathmedum** Hendel. 1913. Deutsch. ent. Zeit. 1913; 628. Peru.
  - **C. decumanum** Bezzi. 1914. Deutsch. ent. Zeit. 1914; 199. Paraguay.
  - **C. fumipenne** Hendel. 1913. Deutsch. ent. Zeit. 1913; 626. Bolivia.
  - **C. fuscipennis** Macquart. 1842. Dipt. Exot. 2; 3; 260 (*Diastata*). Africa.
  - **C. gibbum** Fabricius. 1805. Syst. Antl. 297 (*Musca*). South America.
  - *C. gibba* Perris. 1839. Ann. Soc. Ent. Paris 1; 8; 50 (not *gibbum* Fabricius). Synonym of *C. anus* Meigen.
  - **C. helvum** Loew. 1862. Berl. ent. Zeit. 6 (*Diplocentra*). United States.
  - **C. impunctatum** Hendel. 1913. Deutsch. ent. Zeit. 1913; 625. Peru.
  - **C. murinum** Hendel. 1913. Deutsch. ent. Zeit. 1913; 622. Peru.

CURTONOTUM—continued.
C. perrisi Schiner. 1864. Faun. Austr. 2; 22. Synonym of *C. anus* Meigen.
C. pictipennis Thomson. 1870. Eugen. Resa. (*Geomyza*). South Africa.
C. quadrimacula Walker. 1849. List Dipt. Ins. 4. Sierra Leone.
C. simplex Schiner. 1868. Novara 237. Brazil.
C. tæniatum Hendel. 1913. Deutsch. ent. Zeit. 1913; 629. Peru.
C. trypetipenne Hendel. 1913. Deutsch. ent. Zeit. 1913; 620. Peru.
C. vulpinum Hendel. 1913. Deutsch. ent. Zeit. 1913; 627. Peru.
DETTOPSOMYIA Lamb. 1914. Trans. Linn. Soc. London 16; 349.
D. formosa Lamb. 1914. Trans. Linn. Soc. London 16; 350. Seychelles.
DIPLOCENTRA Loew. 1859. Zeits. Ent. Breslau 13; 13. (See *Curtonotum*.)
DROSOMYIELLA Hendel. 1914. Suppl. ent. 3; 113. (See *Leucophenga*.)
DROSOPHILA Fallén. 1823. Dipt. Suec. Geomyz. 2; 4.
D. abbreviata de Meijere. 1911. Tijd. Ent. 54; 400. To *Leucophenga*.
D. aberrans Lamb. 1914. Trans. Linn. Soc. London 16; 334. Seychelles.
D. abicornis [sic!] de Meijere. 1915. Tijd. Ent., Suppl. 58. Simalu.
D. aceti Kollar. 1851. S. B. K. Akad. Wien. Synonym of *D. funebris* Fabricius.
D. adspersa Mik. 1886. Wien. ent. Zeit. 5; 328. Synonym of *D. repleta* Wollaston.
D. adusta Loew. 1862. Berlin. ent. Zeit. 6. To *Scaptomyza*.
D. affinis Sturtevant. 1916. Ann. Ent. Soc. Amer. 9; 334. United States.
D. alabamensis Sturtevant. 1918. Jour. N. Y. Ent. Soc. 26; 38. Alabama.
D. albiceps de Meijere. 1914. Tijd. Ent. 57; 258. To *Leucophenga*, which was recognized as a subgenus in the description.
D. albicincta de Meijere. 1908. Tijd. Ent. 51. To *Leucophenga*.
D. albilabris Zetterstedt. 1860. Dipt. Scand. 14; 6425. To *Stegana*.
D. albincisa de Meijere. 1911. Tijd. Ent. 54; 409. Java.
D. albipes Walker. 1852. Dipt. Saund. 4. United States.
D. albirostris Sturtevant. This paper. Panama.
D. alboguttata Wahlberg. 1838. K. Vet. Akad. Handl. 22. To *Stegana*.
D. albonotata de Meijere. 1911. Tijd. Ent. 54; 408. Java.
D. albopunctata Becker. 1900. Act. Soc. Scient. Fenn. 26. To *Chymomyza*.
D. alfari Sturtevant. This paper. Costa Rica.
D. alternata de Meijere. 1911. Tijd. Ent. 54; 402. Java.
D. amabilis de Meijere. 1911. Tijd. Ent. 54; 405. Java.
D. amœna Loew. 1862. Berl. ent. Zeit. 6. To *Chymomyza*.
D. ampelophila Loew. 1862. Berl. ent. Zeit. 6. Synonym of *D. melanogaster* Meigen.
D. analis Macquart. 1843. Dipt. Exot. 2; 3; 258. Algeria.
D. ananassæ Doleschall. 1858. Nat. Tijd. Ned. Ind. 17: 128; 89. Amboina.
D. andalusiaca Strobl. 1906. Mem. Soc. Espan. 3; 372. Spain.
D. angusta de Meijere. 1915. Tijd. Ent. 58, suppl. Simalu.
D. angustipennis de Meijere. 1911. Tijd. Ent. 54; 413. Java.
D. annularis Sturtevant. 1916. Ann. Ent. Soc. Amer. 9; 327. West Indies. New name for *D. annulata* Williston, not Fallén.
D. annulata Fallén. 1813. Vet. Akad. Handl. (*Notiphila*). *Drosophila* Zetterstedt. 1847. Dipt. Scand. 6. To *Periscelis*.
D. annulata Williston. 1896. Trans. Ent. Soc. London, 1896; 409. New name is *D. annularis* Sturtevant.
D. anomalipes Grimshaw. 1901. Fauna Haw. 3; 62. Hawaiian Islands.
D. apicalis Walker. 1853. Ins. Britt. 2; 238; 6. To *Scaptomyza*.
D. apicata Thomson. 1870. Eugen. Resa. To *Scaptomyza*. Is a synonym of *S. terminalis* Loew.
D. apicifera Adams. 1905. Kans. Univ. Sci. Bull. 3; 185. To *Leucophenga*.
D. approximata Zetterstedt. 1847. Dipt. Scand. 6. Europe.
D. argentata de Meijere. 1914. Tijd. Ent. 57; 258. To *Leucophenga*, which was recognized as a subgenus.
D. atra Walker. 1852. Ins. Saund. 4; 412. Brazil.
D. balteata Bergroth. 1894. Ent. Zeit. Stettin 55. Queensland.
D. basilaris Adams. 1905. Kans. Univ. Sci. Bull. 3; 184. To *Leucophenga*.

DROSOPHILA—continued.

D. bellula Bergroth. 1894. Ent. Zeit. Stettin 55. To *Leucophenga*.
D. bellula Williston. 1896. Trans. Ent. Soc. London. 1896; 410. New name is *D. pulchella* Sturtevant.
D. bicolor de Meijere. 1911. Tijd. Ent. 54; 399. Java.
D. bilineata Williston. 1896. Trans. Ent. Soc. London 1896; 409. St. Vincent.
D. bimaculata Loew. 1865. Berl. ent. Zeit. 9. To *Leucophenga*.
D. binotata de Meijere. 1914. Tijd. Ent. 57; 257. Java.
D. bistriata de Meijere. 1911. Tijd. Ent. 54; 397. Java.
D. brevis Walker. 1852. Dipt. Saund. 4. United States.
D. bromeliæ Sturtevant. This paper. Cuba.
D. brouni Hutton. 1901. Trans. N. Zeal. Inst. 33. Auckland Island.
D. brunnea de Meijere. 1911. Tijd. Ent. 54; 401. Java.
D. busckii Coquillett. 1901. Ent. News 12; 16. United States.
D. caliginosa Lamb. 1914. Trans. Linn. Soc. London 16; 341. Seychelles.
D. calloptera Schiner. 1868. Novara 239. South America.
D. cameraria Haliday. 1833. Ent. Mag. 1; 174. Ireland.
D. cardini Sturtevant. 1916. Ann. Ent. Soc. Amer. 9; 336. Cuba, etc.
D. caribbea Sturtevant. 1916. Ann. Ent. Soc. Amer. 9; 335. Cuba, etc.
D. carinata Grimshaw. 1901. Faun. Haw. 3; 70. Hawaiian Islands.
D. cellaris Walker. 1853. Ins. Britt. 2; 237. Based on *Musca cellaris* Linnæus, which according to Schiner (Fauna Austr. 2; 279) is probably a phorid.
D. cincta de Meijere. 1911. Tijd. Ent. 54; 395. To *Leucophenga*, which was recognized as a subgenus.
D. cinerella Fallén. 1823. Dipt. Suec. Geomyz. 7. Europe.
D. clarkii Hutton. 1901. Trans. N. Zeal. Inst. 33. Auckland Island.
D. coffeata Williston. 1896. Trans. Ent. Soc. London 1896; 409. St. Vincent.
D. coffeina Schiner. 1868. Novara 238. Tahiti.
D. cognata Grimshaw. 1901. Faun. Haw. 3; 69. Hawaiian Islands.
D. colorata Walker. 1849. List Dipt. Ins. 4. New York.
D. confusa Staeger. 1837. Kröjers Tidskr. 1; 18. Europe.
D. congesta Zetterstedt. 1847. Dipt. Scand. 6. Europe.
D. conspicua Grimshaw. 1901. Faun. Haw. 3; 59. Hawaiian Islands.
D. convergens de Meijere. 1911. Tijd. Ent. 54; 400. To *Stegana*.
D. costata Zetterstedt. 1838. Ins. Lapp. 776; 5. To *Chymomyza*.
D. crassifemur Grimshaw. 1901. Faun. Haw. 3; 66. Hawaiian Islands.
D. crucigera Grimshaw. 1902. Faun. Haw. 3, suppl.; 86. Hawaiian Islands.
D. curvipennis Fallén. 1823. Dipt. Suec. Geomyz. To *Stegana*.
D. debilis Walker. 1849. List Dipt. Ins. 4; 1109. Sierra Leone.
D. decemguttata Walker. 1852. Dipt. Saund. 4; 411. United States.
D. dimidiata Loew. 1862. Berl. ent. Zeit. 6. To *Mycodrosophila*.
D. distincta Egger. 1862. Verh. zool. bot. Ges. 12. To *Chymomyza*.
D. dorsalis Walker. 1865. Proc. Linn. Soc. 8; 128; 70. New Guinea.
D. dubia Sturtevant. This paper. Cuba.
D. duncani Sturtevant. 1918. Bull. Amer. Mus. Nat. Hist. 38; 446. Illinois.
D. earlei Sturtevant. 1916. Ann. Ent. Soc. Amer. 9; 329. Cuba, etc.
D. enderbii Hutton. 1902. Trans. N. Zeal. Inst. 34; 174. Auckland Island.
D. excita Giglio-Tos. 1893. Boll. R. Univ. Torino 8. Is an ephydrine.
D. exigua Grimshaw. 1901. Faun. Haw. 3; 72. Hawaiian Islands.
D. facialis Adams. 1905. Kans. Univ. Sci. Bull. 3; 183. Rhodesia.
D. fasciata Meigen. 1830. Syst. Beschr. 6. Europe.
D. fasciola Williston. 1896. Trans. Ent. Soc. London 1896; 410. St. Vincent.
D. fenestrarum Fallén. 1823. Dipt. Suec. Geomyz. 6. Europe.
D. finigutta Walker. 1859. Proc. Linn. Soc. 3; 126. East Indies.
D. finitima Lamb. 1914. Trans. Linn. Soc. 16; 340. Seychelles.
D. flava Fallén. 1823. Dipt. Suec. Geomyz. 7. To *Scaptomyza*.
D. flaveola Meigen. 1830. Syst. Beschr. 6; 66; 5. To *Scaptomyza*.
D. flaviceps Grimshaw. 1901. Faun. Haw. 3; 63. Hawaiian Islands.
D. flavipennis Zetterstedt. 1838. Ins. Lapp. 777; 8. Is a synonym of *Scaptomyza graminum* Fallén.

DROSOPHILA—continued.

D. flavipes Meigen. 1830. Syst. Beschr. 6 (*Opomyza*). Germany.
D. flaviseta Adams. 1905. Kans. Univ. Sci. Bull. 3; 184. To *Leucophenga*.
D. flexa Loew. 1865. Berl. ent. Zeit. 9. Cuba.
D. floræ Sturtevant. 1916. Ann. Ent. Soc. Amer. 9; 339. Cuba, etc.
D. fracticosta Lamb. 1914. Trans. Linn. Soc. 16; 329. To *Mycodrosophila*.
D. frontalis Williston. 1896. Trans. Ent. Soc. Lond. 1896; 413. To *Leucophenga*.
D. frontata de Meijere. 1916. Tijd. Ent. 59. Java.
D. fronto Walker. 1852. Dipt. Saund. 4; 410. United States.
D. funebris Fabricius. 1787. Mant. Ins. 2; 345; 33 (*Musca*). Europe.
D. fusca Coquillett. 1900. Proc. U. S. Nat. Mus. 22. Porto Rico.
D. fuscimana Zetterstedt. 1838. Ins. Lapp. 776; 6. To *Chymomyza*.
D. fuscula Fallén. 1823. Dipt. Suec. Geomyz. To *Diastata*.
D. fuscula Meigen. 1830. Syst. Beschr. 6. Europe.
D. gibbosa de Meijere. 1914. Tijd. Ent. 57; 264. To *Leucophenga*, which was recognized as a subgenus.
D. gigantea Thomson. 1870. Eugen. Resa 596. Buenos Aires.
D. glabra Fallén. 1823. Dipt. Suec. Geomyz. 8. To *Camilla*.
D. graminum Fallén. 1823. Dipt. Suec. Geomyz. 8; 11. To *Scaptomyza*.
D. gratiosa de Meijere. 1911. Tijd. Ent. 54; 404. To *Mycodrosophila*.
D. grimshawi Oldenberg. 1914. Arch. Naturgesch. 80; A; 2; 23. New name for *D. variegata* Grimshaw, not Fallén. Hawaiian Islands.
D. griseola Zetterstedt. 1847. Dipt. Scand. 6. To *Scaptomyza*.
D. grossipalpis Lamb. 1914. Trans. Linn. Soc. 16; 328. To *Leucophenga*. which was recognized as a subgenus.
D. guttifera Walker. 1849. List. Dipt. Ins. 4. Florida.
D. guttiventris de Meijere. 1908. Tijd. Ent. 51; 331. To *Leucophenga*, which was recognized as a subgenus.
D. haleakalæ Grimshaw. 1901. Faun. Haw. 3; 64. Hawaiian Islands.
D. hawaiiensis Grimshaw. 1901. Faun. Haw. 3; 60. Hawaiian Islands.
D. hirticornis de Meijere. 1914. Tijd. Ent. 57; 261. Java.
D. hirtipes Lamb. 1914. Trans. Linn. Soc. 16; 337. Seychelles.
D. histrio Meigen. 1830. Syst. Beschr. 6. Europe.
D. humeralis Grimshaw. 1901. Faun. Haw. 3; 64. Hawaiian Islands.
D. hydei Sturtevant. This paper. Florida, etc.
D. hypocausta Osten Sacken. 1882. Berl. ent. Zeit. 26; 245. Philippines.
D. illata Walker. 1860. Proc. Linn. Soc. 4; 168; 227. Macassar.
D. illota Williston. 1896. Trans. Ent. Soc. London 1896; 415. St. Vincent.
D. immatura Walker. 1849. List. Dipt. Ins. 4; 1108. Loc. inc.
D. immigrans Sturtevant. This paper. New York, etc.
D. imparata Walker. 1859. Proc. Linn. Soc. 3; 126; 164. Is a synonym of *D. ananassæ* Doleschall (de Meijere. 1908. Tijd. Ent. 51).
D. inæqualis Grimshaw. 1901. Faun. Haw. 3; 69. Hawaiian Islands.
D. incana Meigen. 1830. Syst. Beschr. 6. To *Scaptomyza*.
D. inconspicua de Meijere. 1914. Tijd. Ent. 57; 262. Java.
D. infuscata Grimshaw. 1901. Faun. Haw. 3; 63. Hawaiian Islands.
D. ingrata Haliday. 1833. Ent. Mag. 1. Great Britain.
D. insulana Schiner. 1868. Novara 240. To *Leucophenga*.
D. inversa Walker. 1861. Dipt. Saund.; Trans. Ent. Soc. 5. United States.
D. johni Pokorny. 1896. Mitt. naturw. Ver. Troppau 4. To *Mycodrosophila*. Is a synonym of *M. pœcilogastra* Loew.
D. jucunda Lamb. 1914. Trans. Linn. Soc. 16; 339. Seychelles.
D. lacteoguttata Portschinsky. 1891. Hor. Ent. Ross. 26; 226. To *Stegana*.
D. lanaiensis Grimshaw. 1901. Faun. Haw. 3; 60. Hawaiian Islands.
D. lata Becker. 1907. St. Petersb. Ann. Mus. Zool. 12; 306. Chinese Turkestan.
D. lateralis Walker. 1860. Proc. Linn. Soc. 4; 168. Macassar.
D. latestriata Becker. 1908. Mitt. zool. Mus. 4; 157. Canary Islands.
D. latifasciata de Meijere. 1914. Tijd. Ent. 57; 261. Java.
D. latifrons Adams. 1905. Kans. Univ. Sci. Bull. 3; 182. Rhodesia.
D. limbata van Roser. 1840. Württ. Corrbl. Germany.

DROSOPHILA—continued.

D. limbata Williston. 1896. Trans. Ent. Soc. London. 1896; 414. New name is *D. nebulosa* Sturtevant.
D. limbipennis de Meijere. 1908. Tijd. Ent. 51. To *Leucophenga*, which was recognised as a subgenus.
D. linearis Walker. 1852. Dipt. Saund. 4; 411. United States.
D. lineata van der Wulp. 1881. Midd. Sumatra, Dipt. Sumatra.
D. lineolata de Meijere. 1914. Tijd. Ent. 57; 254. Java.
D. littoralis Meigen. 1830. Syst. Beschr. 6; 87. Germany.
D. litorella Meigen. 1838. Syst. Beschr. 7 (*Hydrellia*). Germany.
D. longiseta Grimshaw. 1901. Faun. Haw. 3; 68. Hawaiian Islands.
D. lurida Walker. 1860. Proc. Linn. Soc. 4; 168; 228. Macassar.
D. splendida luteipes Sturtevant. This paper. Cuba.
D. lutzii Sturtevant. 1916. Ann. Ent. Soc. Amer. 9; 340. Cuba, etc.
D. maculata Dufour. 1839. Ann. Scienc. Nat. 49. To *Leucophenga*.
D. maculipennis Gimmerthal. 1847. Corrbl. Riga 1. Europe.
D. maculiventris van der Wulp. 1897. Termes. Fuzetek. 20. Ceylon.
D. maculiventris de Meijere. 1908. Tijd. Ent. 51. New name is *Leucophenga guttiventris* de Meijere.
D. maculosa Coquillett. 1895. Proc. Acad. Nat. Sci. Phila. 47. To *Leucophenga*.
D. mansura Adams. 1905. Kans. Univ. Sci. Bull. 3; 185. To *Leucophenga*.
D. marginella Zetterstedt. 1838. Ins. Lapp. Is a synonym of *Diastata costata* Meigen.
D. marmoria Hutton. 1901. Trans. N. Zeal. Inst. 33; 91. Auckland Island. Is probably a synonym of *D. repleta* Wollaston.
D. mauiensis Grimshaw. 1901. Faun. Haw. 3; 67. Hawaiian Islands.
D. maura de Meijere. 1911. Tijd. Ent. 54; 406. Java.
D. megaspis Bezzi. 1908. Boll. Soc. Ent. 39; 191. Eritrea.
D. melanderi Sturtevant. 1916. Ann. Ent. Soc. Amer. 9; 337. Washington.
D. melanica Sturtevant. 1916. Ann. Ent. Soc. Amer. 9; 332. Alabama, etc.
D. melanissima Sturtevant. 1916. Ann. Ent. Soc. Amer. 9; 333. Alabama, etc.
D. melanogaster Meigen. 1830. Syst. Beschr. 6. Europe.
D. melanogaster Macquart. 1842. Dipt. Exot. 2; 3; 258. Algiers.
D. melanosoma Grimshaw. 1901. Faun. Haw. 3; 68. Hawaiian Islands.
D. melanospila Walker. 1859. Proc. Linn. Soc. 3; 126; 163. Aroe.
D. metallescens de Meijere. 1914. Tijd. Ent. 57; 265. Java.
D. metallica Sturtevant. This paper. Cuba.
D. metzii Sturtevant. This paper. Cuba.
D. mexicana Macquart. 1842. Dipt. Exot. 2; 3; 259. Mexico.
D. minuta Walker. 1852. Dipt. Saund. 4; 412. United States.
D. modesta Sturtevant. 1916. Ann. Ent. Soc. Amer. 9; 338. Is a synonym of *D. tripunctata* Loew.
D. molokaiensis Grimshaw. 1901. Faun. Haw. 3; 67. Hawaiian Islands.
D. monticola Grimshaw. 1901. Faun. Haw. 3; 69. Hawaiian Islands.
D. montium de Meijere. 1916. Tijd. Ent. 59. Java.
D. mulleri Sturtevant. This paper. Texas, etc.
D. multipuncta Loew. 1866. Berl. Ent. Zeit. 10. Is a synonym of *D. guttifera* Walker.
D. mutabilis Adams. 1905. Kans. Univ. Sci. Bull. 3; 187. To *Leucophenga*.
D. nana Williston. 1896. Trans. Ent. Soc. London 1896; 416. St. Vincent.
D. nasalis Grimshaw. 1901. Faun. Haw. 3; 66. Hawaiian Islands.
D. nasuta Lamb. 1914. Trans. Linn. Soc. 16; 346. Seychelles.
D. nebulosa Sturtevant. 1916. Ann. Ent. Soc. Amer. 9; 327. New name for *D. limbata* Williston, not van Roser. West Indies.
D. neglecta Sturtevant. Manuscript name, used by Metz. 1916. Jour. Exper. Zool. 21, legend to plate 2.
D. nigerrima Lamb. 1914. Trans. Linn. Soc. 16; 331. Seychelles. To *Mycodrosophila*.
D. nigra Grimshaw. 1901. Faun. Haw. 3; 62. Hawaiian Islands.
D. nigra de Meijere. 1908. Tijd. Ent. 51. New name is *D. nigricolor* de Meijere.

DROSOPHILA—continued.

D. nigriceps Meigen. 1830. Syst. Beschr. 7; 378. Europe.

D. nigricolor Strobl. 1898. Mitt. Ver. Steiermark 34. Styria.

D. nigricolor de Meijere. 1911. Tijd. Ent. 54; 399. New name for *D. nigra* de Meijere, not Grimshaw. Java.

D. nigricornis Loew. Manuscript name, used by Peck. 1884. Science, 4; 25.

D. nigrimana Meigen. 1830. Syst. Beschr. 6; 87. To *Chymomyza*.

D. nigrita Haliday. 1833. Ent. Mag. 1. Europe.

D. nigriventris Macquart. 1842. Dipt. Exot. 2; 3; 259. To *Leucophenga*.

D. nigriventris Zetterstedt. 1847. Dipt. Scand. 6; 2557. Is a synonym of *D. melanogaster* Meigen.

D. nigrobrunnea Lamb. 1914. Trans. Linn. Soc. 16; 332. To *Mycodrosophila*.

D. nigropunctata van der Wulp. 1892. Tijd. Ent. 34. Java. Is probably a synonym of *D. repleta* Wollaston.

D. nigrosparsa Strobl. 1898. Mitt. Ver. Steiermark 34. Styria.

D. nitidiventris Macquart. 1835. Suit. Buff. 2. Is a synonym of *D. fenestrarum* Fallén.

D. niveopunctata Dufour. 1846. C. R. Acad. Sci. Paris 25. Nom. nud. (Oldenberg. 1914. Arch. Naturgesch. 80; A; 2).

D. notabilis Lamb. 1914. Trans. Linn. Soc. 16; 329. Seychelles.

D. obesa Loew. 1872. Berl. ent. Zeit. 16. To *Pseudophortica*.

D. obscura Fallén. 1823. Dipt. Suec. Geomyz. 6. Europe.

D. obscurata de Meijere. 1911. Tijd. Ent. 54; 410. Java.

D. obscuricornis Grimshaw. 1901. Faun. Haw. 3; 71. Hawaiian Islands.

D. obscurifrons Grimshaw. 1901. Faun. Haw. 3; 72. Hawaiian Islands.

D. obscuripennis Loew. 1865. Berl. ent. Zeit. 9. To *Leucophenga*.

D. ochracea Grimshaw. 1901. Faun. Haw. 3; 61. Hawaiian Islands.

D. olaæ Grimshaw. 1901. Faun. Haw. 3; 66. Hawaiian Islands.

D. opaca Williston. 1896. Trans. Ent. Soc. London 1896; 411. St. Vincent.

D. orbitalis Sturtevant. 1916. Ann. Ent. Soc. Amer. 9; 336. To *Zaprionus*.

D. ordinaria Coquillett. 1904. Proc. Ent. Soc. Wash. 6. New Hampshire.

D. ornatipennis Williston. 1896. Trans. Ent. Soc. London 1896; 407. Is a variety of *D. calloptera* Schiner. St. Vincent.

D. ornatipennis de Meijere. 1914. Tijd. Ent. 57; 256. To *Leucophenga*, which was recognized as a subgenus.

D. pallida Zetterstedt. 1847. Dipt. Scand. 6. Is a synonym of *Scaptomyza flaveola* Meigen.

D. pallida Williston. 1896. Trans. Ent. Soc. London 1896; 415. New name is *D. willistoni* Sturtevant.

D. pallipes Dufour. 1846. Ann. Soc. Ent. 1846. Europe.

D. pallipes Lamb. 1914. Trans. Linn. Soc. 16; 342. Seychelles.

D. palpalis Adams. 1905. Kans. Univ. Sci. Bull. 3; 185. To *Leucophenga*.

D. paradoxa Lamb. 1918. Bull. Ent. Research. 9; 159. Trinidad.

D. parva Grimshaw. 1901. Faun. Haw. 3; 65. Hawaiian Islands.

D. paucipuncta Grimshaw. 1901. Faun. Haw. 3; 62. Hawaiian Islands.

D. perkinsi Grimshaw. 1901. Faun. Haw. 3; 59. Hawaiian Islands.

D. phalerata Meigen. 1830. Syst. Beschr. 6. Europe.

D. picta Zetterstedt. 1847. Dipt. Scand. 6. Europe.

D. picticornis Grimshaw. 1901. Faun. Haw. 3; 57. Hawaiian Islands.

D. pictipennis Kertész. 1901. Termes. Fuzetek. 24. New Guinea.

D. pictipes de Meijere. 1911. Tijd. Ent. 54; 411. Java.

D. pilimana Grimshaw. 1901. Faun. Haw. 3; 61. Hawaiian Islands.

D. pilosula Becker. 1908. Mitt. zool. Mus. 4; 156. Canary Islands.

D. pinguis Walker. 1865. Proc. Linn. Soc. 8; 128; 69. New Guinea.

D. pistula de Meijere. 1911. Tijd. Ent. 54; 412. Java.

D. plagiata Bezzi. 1908. Denkschr. med. Ges. 13; 197. South Africa.

D. pleuralis Williston. 1896. Trans. Ent. Soc. London, 1896; 411. To *Mycodrosophila*.

D. plumosa Grimshaw. 1901. Faun. Haw. 3; 72. Hawaiian Islands.

D. plurilineata Villeneuve. 1911. Wien. ent. Zeit. 30; 83. Is a synonym of *D. busckii* Coquillett.

DROSOPHILA—continued.

D. poeyi Sturtevant. This paper. Cuba.
D. polita Grimshaw. 1901. Faun. Haw. 3; 71. Hawaiian Islands.
D. pollinosa Williston. 1896. Trans. Ent. Soc. London 1896; 414. To *Paratissa.*
D. preciosa de Meijere. 1911. Tijd. Ent. 55. Java.
D. procnemis Williston. 1896. Trans. Ent. Soc. London 1896; 412. To *Chymomyza.*
D. prognatha Sturtevant. 1916. Ann. Ent. Soc. Amer. 9; 340. Porto Rico, etc.
D. projectans Sturtevant. 1916. Ann. Ent. Soc. Amer. 9; 342. To *Mycodrosophila.*
D. proxima Adams. 1905. Kans. Univ. Sci. Bull. 3; 186. To *Leucophenga.*
D. pseudomelanica Sturtevant. 1916. Ann. Ent. Soc. Amer. 9; 333. Virginia, etc.
D. pugionata de Meijere. 1915. Tijd. Ent. 58, suppl. Simalu.
D. pulchella Sturtevant. 1916. Ann. Ent. Soc. Amer. 9; 327. St. Vincent. New name for *D. bellula* Williston, not Bergroth.
D. pulchra Schiner. 1868. Novara 239. South America.
D. pumilio de Meijere. 1908. Tijd. Ent. 51. Java.
D. punctipennis van der Wulp. 1896. Cat. Descr. Dipt. South Asia. (*Discomyza*) East Indies. Generic reference by de Meijere. 1908. Tijd. Ent. 51.
D. punctiscutata Lamb. 1914. Trans. Linn. Soc. 16; 333. Seychelles.
D. punctulata Loew. 1862. Berl. ent. Zeit. 6; 232. Is a synonym of *D. repleta* Wollaston.
D. pusilla Grimshaw. 1901. Faun. Haw. 3; 70. Hawaiian Islands.
D. putrida Sturtevant. 1916. Ann. Ent. Soc. Amer. 9; 339. Massachusetts, etc.
D. quadrata Sturtevant. 1916. Ann. Ent. Soc. Amer. 9; 341. Alabama, etc.
D. quadrilineata de Meijere. 1911. Tijd. Ent. 54; 396. Java.
D. quadrimaculata Walker. 1856. Dipt. Saund. 4. Is a synonym of *Leucophenga varia* Walker.
D. quadrimaculata Adams. 1905. Kans. Univ. Sci. Bull. 3; 182. Rhodesia.
D. quadripunctata de Meijere. 1908. Tijd. Ent. 51. To *Leucophenga.*
D. quinaria Loew. 1865. Berl. ent. Zeit. 9. United States.
D. ramsdeni Sturtevant. 1916. Ann. Ent. Soc. Amer. 9; 328. Cuba.
D. reamurii Dufour. 1845. Ann. Soc. Ent. 1845. Europe.
D. remota Walker. 1849. List. Dipt. Ins. 4; 4. Tristan da Cunha.
D. repleta Wollaston. 1858. Ann. Mag. Nat. Hist. 41; 117. Madeira.
D. robusta Sturtevant. 1916. Ann. Ent. Soc. Amer. 9; 331. Alabama, etc.
D. ruberrima de Meijere. 1911. Tijd. Ent. 54; 403. Java.
D. rubrostriata Becker. 1908. Mitt. zool. Mus. 4; 155. Is a synonym of *D. busckii* Coquillett.
D. rudis Walker. 1860. Proc. Linn. Soc. 4; 168; 226. Macassar.
D. ruficeps van Roser. 1840. Württ. Corrbl. 1840. Germany.
D. rufifrons Loew. 1873. Berl. ent. Zeit. 17. Hungary.
D. rufipes Meigen. 1830. Syst. Beschr. 6; 87. Germany.
D. rufuloventer Lamb. 1914. Trans. Linn. Soc. 16; 344. Seychelles.
D. salatigæ de Meijere. 1914. Tijd. Ent. 57; 260. To *Leucophenga*, which was recognised as a subgenus.
D. saltans Sturtevant. 1916. Ann. Ent. Soc. Amer. 9; 328. Cuba, etc.
D. semiatra de Meijere. 1914. Tijd. Ent. 57; 265. Java.
D. separata de Meijere. 1911. Tijd. Ent. 54; 406. Java.
D. sericea Lamb. 1914. Trans. Linn. Soc. 16; 326. To *Leucophenga*, which was recognised as a subgenus.
D. setiger Grimshaw. 1901. Faun. Haw. 3; 64. Hawaiian Islands.
D. sharpi Grimshaw. 1901. Faun. Haw. 3; 65. Hawaiian Islands.
D. sigmoides Loew. 1872. Berl. ent. Zeit. 16. United States.
D. silvata de Meijere. 1916. Tijd. Ent. 59. Java.
D. similis Williston. 1896. Trans. Ent. Soc. London 1896; 415. St. Vincent.
D. similis Lamb. 1914. Trans. Linn. Soc. 16; 347. Seychelles.
D. simplex de Meijere. 1914. Tijd. Ent. 57; 266. Java.
D. simulans Sturtevant. 1919. Psyche 26; 153. Florida, etc.
D. slossonæ Coquillett. A manuscript name, used by Johnson. 1913. Bull. Amer. Mus. Nat. Hist. 32.

DROSOPHILA—continued.

D. solennis Walker. 1860. Proc. Linn. Soc. 4; 168; 235. Macassar.
D. sordida Zetterstedt. 1838. Ins. Lapp. 777; 7. Is a synonym of *Scaptomyza graminum* Fallén.
D. sordidapex Grimshaw. 1901. Faun. Haw. 3; 63. Hawaiian Islands.
D. soror Schiner. 1868. Novara 240. Colombia.
D. sororia Williston. 1896. Trans. Ent. Soc. London 1896; 408. St. Vincent.
D. sphærocera Thomson. 1870. Eugen. Resa. 597. Patagonia.
D. spinipes Lamb. 1914. Trans. Linn. Soc. 16; 336. Seychelles.
D. splendida Williston. 1896. Trans. Ent. Soc. London 1896; 412. St. Vincent.
D. spurca Zetterstedt. 1847. Dipt. Scand. 6. Europe.
D. strigifrons de Meijere. 1914. Tijd. Ent. 57; 264. Java.
D. subfasciata de Meijere. 1914. Tijd. Ent. 57; 257. Java.
D. subpollinosa de Meijere. 1914. Tijd. Ent. 57; 263. To *Leucophenga*, which was recognised as a subgenus.
D. sulcata Sturtevant. 1916. Ann. Ent. Soc. Amer. 9; 330. Maryland, etc.
D. superba Sturtevant. 1916. Ann. Ent. Soc. Amer. 9; 342. Guatemala.
D. tarsalis Walker. 1852. Dipt. Saund. 4; 412. Brasil.
D. tarsata Schiner. 1868. Novara 240. South America.
D. tectifrons de Meijere. 1914. Tijd. Ent. 57; 263. To *Leucophenga*, which was recognised as a subgenus.
D. terminalis Loew. 1863. Berl. ent. Zeit. 7. To *Scaptomyza*.
D. testacea van Roser. 1840. Württ. Corrbl. 1840. Is a synonym of *Scaptomyza flava* Fallén.
D. thoracis Williston. 1896. Trans. Ent. Soc. London 1896; 411. To *Mycodrosophila*.
D. tjibodas de Meijere. 1916. Tijd. Ent. 59. Java.
D. torrei Sturtevant. This paper. Cuba.
D. transversa Fallén. 1823. Dipt. Suec. Geomyz. 6; 5. Europe.
D. triangulifer Lamb. 1914. Trans. Linn. Soc. 16; 343. Seychelles.
D. trifasciata de Meijere. 1916. Tijd. Ent. 59. Java.
D. tripunctata Loew. 1862. Berl. ent. Zeit. 6. District of Columbia.
D. triseta de Meijere. 1911. Tijd. Ent. 54; 402. Java.
D. tristani Sturtevant. This paper. Costa Rica.
D. tristis Fallén. 1823. Dipt. Suec. Geomyz. 7; 7. Europe.
D. trivittata Strobl. 1893. Wien. ent. Zeit. 12. Styria.
D. undulata Grimshaw. 1901. Faun. Haw. 3; 58. Hawaiian Islands.
D. ungarensis de Meijere. 1911. Tijd. Ent. 54; 407. Java.
D. unicolor de Meijere. 1914. Tijd. Ent. 57; 266. Java.
D. unimaculata Strobl. 1893. Wien. ent. Zeit. 12. Austria.
D. unistriata Strobl. 1900. Wiss. Mitt. Bosn. 7. Dalmatia.
D. ustulata de Meijere. 1908. Tijd. Ent. 51. Java.
D. uvarum Rondani. 1875. Boll. Com. Agr. Parm. 1875. Is a synonym of *D. melanogaster* Meigen.
D. valida Walker. 1858. Dipt. Saund.; Trans. Ent. Soc. 4. To *Minettia*.
D. varia Walker. 1849. List Dipt. Ins. 4. To *Leucophenga*.
D. variegata Fallén. 1823. Dipt. Suec. Geomyz. 5; 2. To *Stegana*.
D. variegata Grimshaw. 1901. Faun. Haw. 3; 57. New name is *D. grimshawi* Oldenberg.
D. varifrons Grimshaw. 1901. Faun. Haw. 3; 71. Hawaiian Islands.
D. variopicta Becker. 1908. Mitt. zool. Mus. 4; 156. Canary Islands.
D. varipes Macquart. 1835. Suit. Buff. 2; 550. France.
D. verticis Williston. 1896. Trans. Ent. Soc. London 1896; 413. St. Vincent.
D. virginea Meigen. 1830. Syst. Beschr. 6; 84. Synonym of *D. fenestrarum* Fallén.
D. virilis Sturtevant. 1916. Ann. Ent. Soc. Amer. 9; 330. New York.
D. vittata Coquillett. 1895. Proc. Acad. Nat. Sci. Phila. 47. To *Scaptomyza*.
D. vittatifrons Williston. 1896. Trans. Ent. Soc. London 1896; 408. St. Vincent.
D. willistoni Sturtevant. 1916. Ann. Ent. Soc. Amer. 9; 327. New name for *D. pallida* Williston, not Zetterstedt. St. Vincent.

D. **xanthostoma** Grimshaw. 1901. Faun. Haw. 3; 68. Hawaiian Islands.

DROSOPHILURA Hendel. 1913. Ent. Mitt. 2; 387. (See *Zygothrica*.)

EOSTEGANA Hendel. 1913. Deutsch. ent. Zeit. 390. (See *Stegana*.)

GITONA Meigen. 1830. Syst. Beschr. 6; 129; 215.

G. **distigma** Meigen. 1830. Syst. Beschr. 6; 130. Europe.

G. ornata Meigen. 1830. Syst. Beschr. 6; 176 (*Agromyza*). Perhaps an earlier name for *Acletoxenus formosus* Loew.

G. **perspicax** Knab. 1914. Insec. Inscit. Menstr. 2 (*Gitonides*). Hawaiian Islands, etc.

G. **pruinosus** Bigot. 1888. Expl. scient. Tunes. 10. Tunis.

GITONIDES Knab. 1914. Insec. Inscit. Menstr. 2; 165. (See *Gitona*.)

HYPENOMYIA Grimshaw. 1901. Faun. Haw. 3; 53.

H. **varipennis** Grimshaw. 1901. Faun. Haw. 3; 54. Hawaiian Islands.

IDIOMYIA Grimshaw. 1901. Faun. Haw. 3; 50.

I. **heteroneura** Perkins. 1910. Faun. Haw. 2; 699. Hawaiian Islands.

I. **oahuensis** Grimshaw. 1901. Faun. Haw. 3; 52. Hawaiian Islands.

I. **obscuripes** Grimshaw. 1901. Faun. Haw. 3; 52. Hawaiian Islands.

I. **perkinsi** Grimshaw. 1901. Faun. Haw. 3; 51. Hawaiian Islands.

I. **picta** Grimshaw. 1901. Faun. Haw. 3; 53. Hawaiian Islands.

I. **silvestris** Perkins. 1910. Faun. Haw. 2; 700. Hawaiian Islands.

LEUCOPHENGA Mik. 1886. Wien. ent. Zeit. 317.

L. **abbreviata** de Meijere. 1911. Tijd. Ent. 54; 400 (*Drosophila*). Java.

L. **albiceps** de Meijere. 1914. Tijd. Ent. 57; 258. Java.

L. **albicincta** de Meijere. 1908. Tijd. Ent. 51. Java.

L. **ambigua** Kahl. 1917. Ann. Carn. Mus. 11; 389. Africa.

L. **apicifera** Adams. 1905. Kans. Univ. Sci. Bull. 3; 185 (*Drosophila*). Rhodesia.

L. **argentata** de Meijere. 1914. Tijd. Ent. 57; 258. Java.

L. **argenteiventris** Kahl. 1917. Ann. Carn. Mus. 11; 378. Bolivia.

L. **argenteofasciata** Kahl. 1917. Ann. Carn. Mus. 11; 371. Brasil.

L. **basilaris** Adams. 1905. Kans. Univ. Sci. Bull. 3; 184 (*Drosophila*). Rhodesia.

L. **bellula** Bergroth. 1894. Ent. Zeit. Stett. 55 (*Drosophila*). Queensland.

L. **bimaculata** Loew. 1865. Berl. ent. Zeit. 9 (*Drosophila*). Cuba.

L. **bistriata** Kahl. 1917. Ann. Carn. Mus. 11; 386. Philippines.

L. **brunneipennis** Kahl. 1917. Ann. Carn. Mus. 11; 373. Bolivia.

L. **cincta** de Meijere. 1911. Tijd. Ent. 54; 395. Java.

L. **flaviseta** Adams. 1905. Kans. Univ. Sci. Bull. 3; 184 (*Drosophila*). Rhodesia.

L. **frontalis** Williston. 1896. Trans. Ent. Soc. London 1896; 413 (*Drosophila*). St. Vincent.

L. **gibbosa** de Meijere. 1914. Tijd. Ent. 57; 264. Java.

L. **goodi** Kahl. 1917. Ann. Carn. Mus. 11; 388. Africa.

L. **grossipalpis** Lamb. 1914. Trans. Linn. Soc. 16; 328. Seychelles.

L. **guttiventris** de Meijere. 1908. Tijd. Ent. 51. New name for *Drosophila maculiventris* de Meijere, not van der Wulp. Java.

L. **hasemani** Kahl. 1917. Ann. Carn. Mus. 11; 375. Brasil.

L. **insulana** Schiner. 1868. Novara 240. (*Drosophila*). Nicobar Islands.

L. **invicta** Walker. 1857. Proc. Linn. Soc. (*Helomyza*). Borneo. Generic reference by Czerny, 1904, Wien. ent. Zeit. 23.

L. **leucostoma** Becker. 1908. Ann. Mus. Nat. Hung. 6. Hungary.

L. **limbipennis** de Meijere. 1908. Tijd. Ent. 51. Java.

L. **maculata** Dufour. 1839. Ann. Sci. Nat. 49; 14 (*Drosophila*). Europe.

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